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BEARPAW DAM

MANUAL FOR OPERATION AND MAINTENANCE

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TABLE OF CONTENTS

Page

PROJECT DESCRIPTION 1
- Overview 1
- Embankment 1
- Outlet Works 2
- Spillway 3
- Drains 3
  - Location Map (Figure 1) 5
  - Project Area Map (Figure 2) 6
  - Dam General Layout Map (Figure 3) 7
  - Monitoring Wells Location Map (Figure 4) 8

STATISTICAL INFORMATION 9

OPERATING PROCEDURES 13
- Dam Operator 13
- Method and Schedule of Operation 14
- Gate Operation 14
- Spillway 15
- Safe Drawdown 15
- Storage Determination 16
- Inflow And Outflow Monitoring 16
- Weather Monitoring 16
- Interaction With Other Dams 17
- Emergency 17

INSPECTION AND MONITORING 19
- Structural Features Inspection 19
- Riprap Inspection 20
- Drains 21
- Seepage 21
- Monitoring Wells 21
- Seepage Monitoring 22
- Embankment Monitoring Points 22

MAINTENANCE 23
- Routine Maintenance 23
- Annual Maintenance 24
- Record Keeping 24

REFERENCES 27

TABLE OF CONTENTS (continued)

Page

APPENDICES....................29
- A. RATING CURVES AND TABLES....................A1
  - TABLE 1. SLOPE/ELEVATION/STORAGE TABLE....................A2
  - TABLE 2. ACTIVE STORAGE TABLE....................A4
  - TABLE 3. SPILLWAY RATING CURVE....................A6
- B. INSPECTION CHECKLIST....................B1
- C. DISTRIBUTION LIST....................C1
- D. MONITORING WELL LOGS....................D1
- E. PROJECT DRAWINGS....................E1

PROJECT DESCRIPTIPON

OVERVIEW

Bearpaw Dam is located on Beaver Creek a tributary of the Milk River. The project is in Hill County approximately twenty miles south of the town of Havre, Montana (see Figures 1 and 2). Figure 3 provides a general layout of the dam, spillway and outlet works. Figure 4 provides a monitoring wells locations map.

The dam is owned and managed by the Montana Department of Fish, Wildlife and Parks (DFWP). The dam is located in Beaver Creek Park which is owned and operated by Hill County. The land encompassing the dam and reservoir is leased by the DFWP. The DNRC State Water Projects Bureau (SWPB) inspects the dam annually and provides engineering assistance as needed.

The reservoir is used primarily as a fishery water supply and for public recreation. With the pool at the spillway crest, the reservoir stores 616 acre-feet.

EMBANKMENT

The zoned earthfill embankment was completed in 1958. The dam is 59 feet high with a crest length of 380 feet and a crest width of 18 to 20 feet. The design drawings indicate the cutoff trench extends downwards into the foundation an additional 5 feet, giving the dam a total structural height of 64 feet. The upstream slope is 1V on 3H and the downstream slope is 1V on 2 H. Construction procedures and source of embankment materials are unknown. Reservoir topography indicates borrow may have been taken from the area upstream from the right abutment.

The crest of the dam has a bridge over the spillway and a road across the top of the embankment for access to the east side of the reservoir. The original timber bridge over the spillway was replaced in 1995 with a new concrete bridge. Also in 1995, a pre-cast concrete barrier (Jersey Barrier) parapet was installed on the upstream side of the crest to provide freeboard for wave run up and splash. Additionally, riprap was installed on the upstream face of the dam between the gatehouse and the spillway which previously was without riprap protection.

OUTLET WORKS

The outlet works located near the middle of the dam consist of an intake structure, a reinforced concrete conduit, a concrete wet-well tower, and an outlet structure. The concrete reinforced conduit has a horseshoe-shaped inside cross-section. The bottom of the level horseshoe is 36 inches wide with 18-inch straight sides and a 18-inch curved top. The outlet conduit rests on bedrock and extends about 160 feet upstream from the gate tower and about 153 feet downstream from the gate tower.

The tower consists of two wet cells with each having a 36" x 36" cast iron slide gate (one operating gate and one emergency gate). A 3-inch diameter stem connects each gate to a two speed open gear pedestal lift. The lift mechanism is operated manually and is located in the gatehouse above the wet wells.

The timber-framed, sheet metal gatehouse was replaced with a cinder block structure in 1999. There is a 4-inch iron vent pipe downstream from the operator gate that daylights just outside the gatehouse.

The maximum discharge of the outlet is approximately 170 cfs with the reservoir at the dam crest and approximately 160 cfs with the reservoir at the spillway crest.

Spillway

The spillway is an uncontrolled, reinforced concrete chute located in the left abutment of the dam. The spillway inlet consists on an uncontrolled ogee crest (no gates) with a bridge pier located in the middle of the spillway entrance. The spillway entrance is 50 feet wide with a 1.5 foot wide center bridge pier yielding an effective crest length of 48.5 feet. The top of the sidewalls at the spillway entrance are 8 feet above the spillway crest. The spillway terminates in a flip bucket energy dissipater.

The spillway was rehabilitated in 1995 due to undermining of the lower floor slab that occurred as a result of a broken drain.. The lower half of the spillway and the flip bucket (approximately 100 feet) were removed. The curvature of the spillway floor was reduced to maintain positive pressure on the spillway floor. The new reinforced concrete flip bucket dimensions are the same as the original with a 10 foot radius. The spillway was fenced off to prevent people from falling into the spillway.

The left abutment hillside where the spillway is located has moved and may continue to be moving, and needs to be watched.

The maximum capacity of the spillway with the reservoir at the dam crest is approximately 4000 cfs.

DRAINS

A 8-inch pipe drain exists along the toe of dam near the right abutment. The "as-built" plans shows the drain pipe follows the cut-off trench trough of the downstream toe from the right abutment and terminates just above the conduit outlet. The drain exits just above the outlet conduit.

A 6-inch drain pipe system installed in gravel-sand filters is located under the spillway floor. During the rehabilitation of the spillway in 1995, new drain pipes were added under the lower portion of the spillway that was replaced. This new drain system was connected to the old drain pipe located under the upper portion of the spillway which was not replaced. The spillway drains exit into the downstream channel at four points along the downstream side of the flip bucket. See drawing S1 in Appendix E for a layout of the drain system.

A culvert was placed under the road going down to the crest of the dam to drain the road ditch to the reservoir.

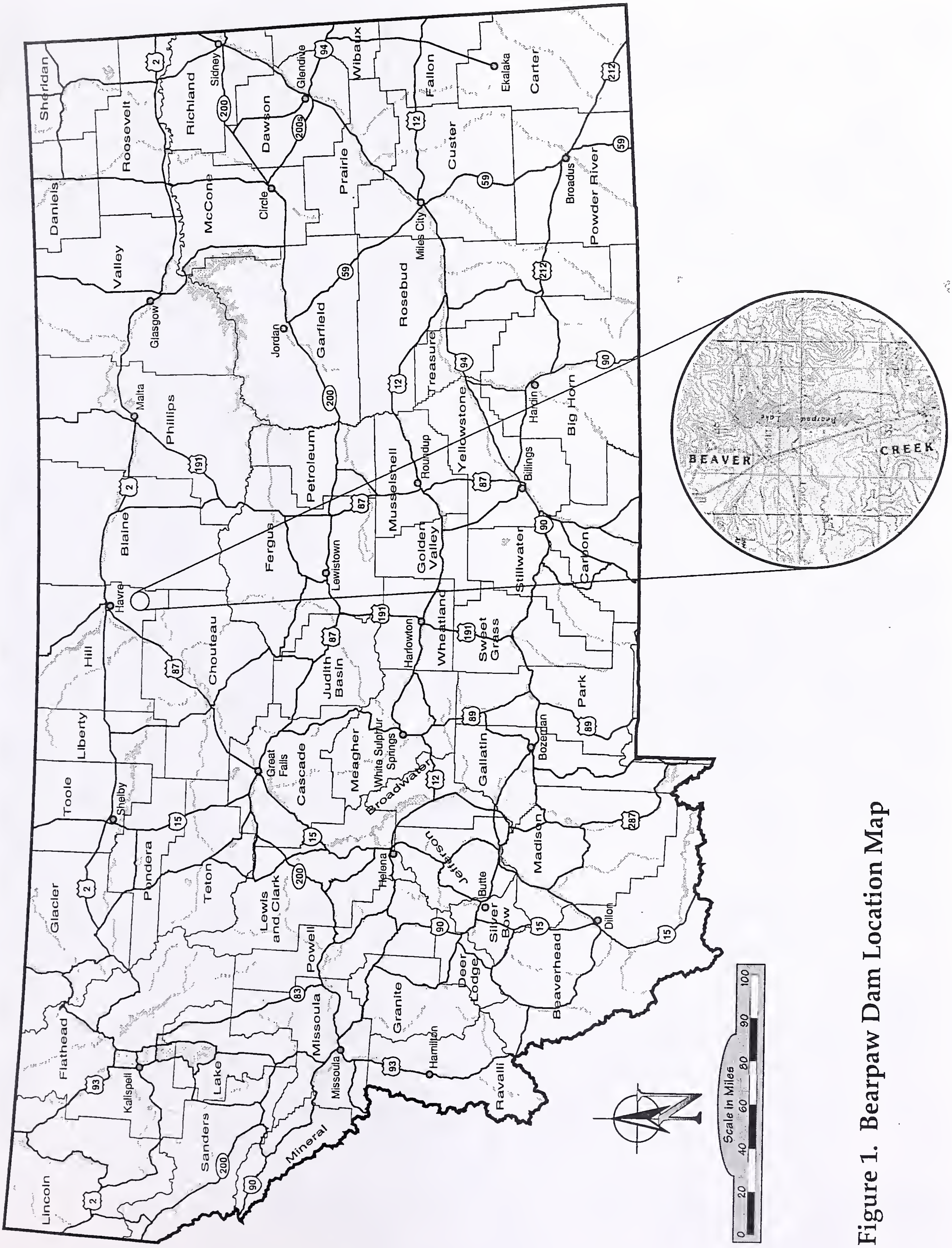

Figure 1. Bearpaw Dam Location Map

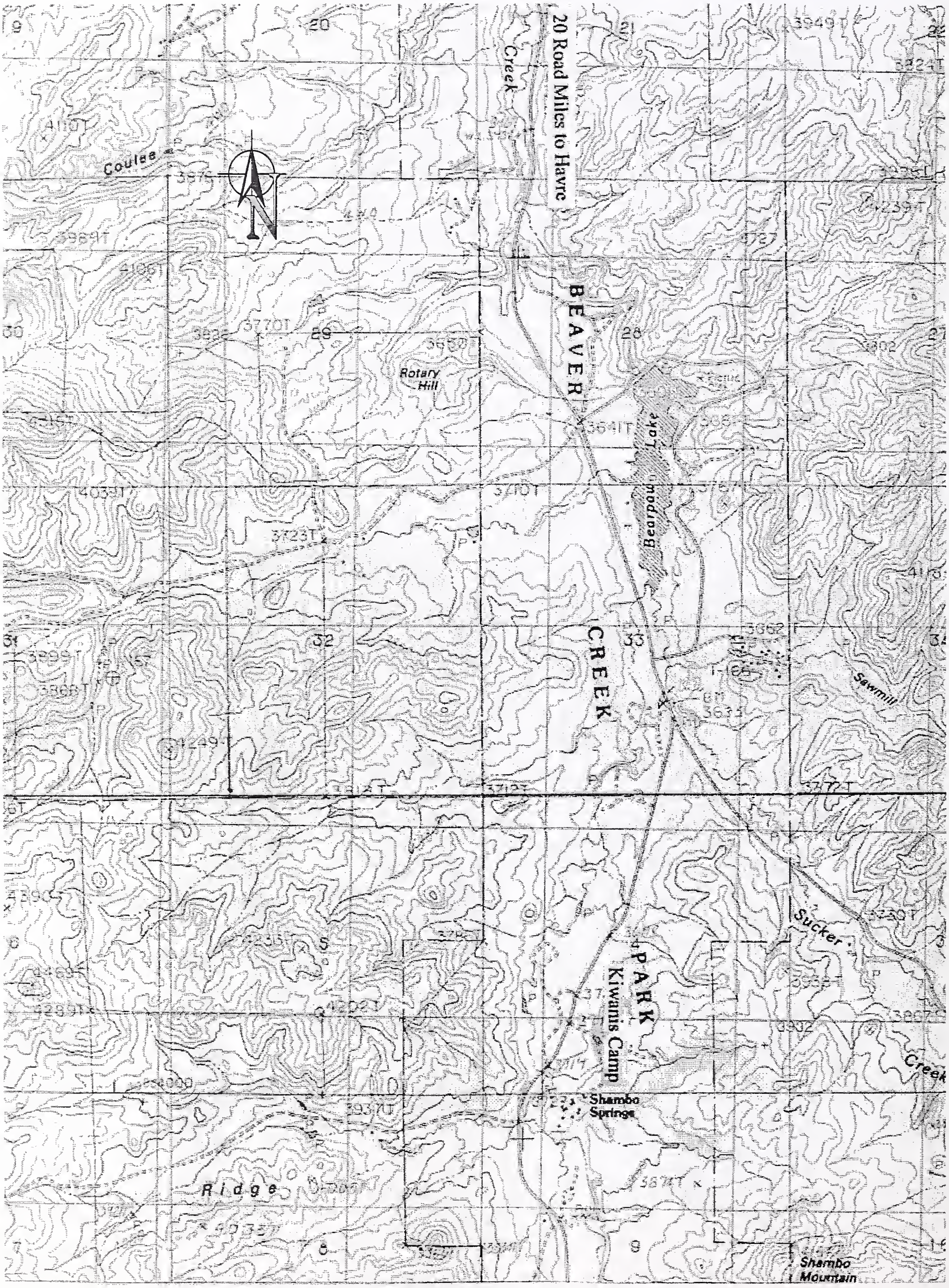

Figure 2. Bearpaw Dam Project Area Map

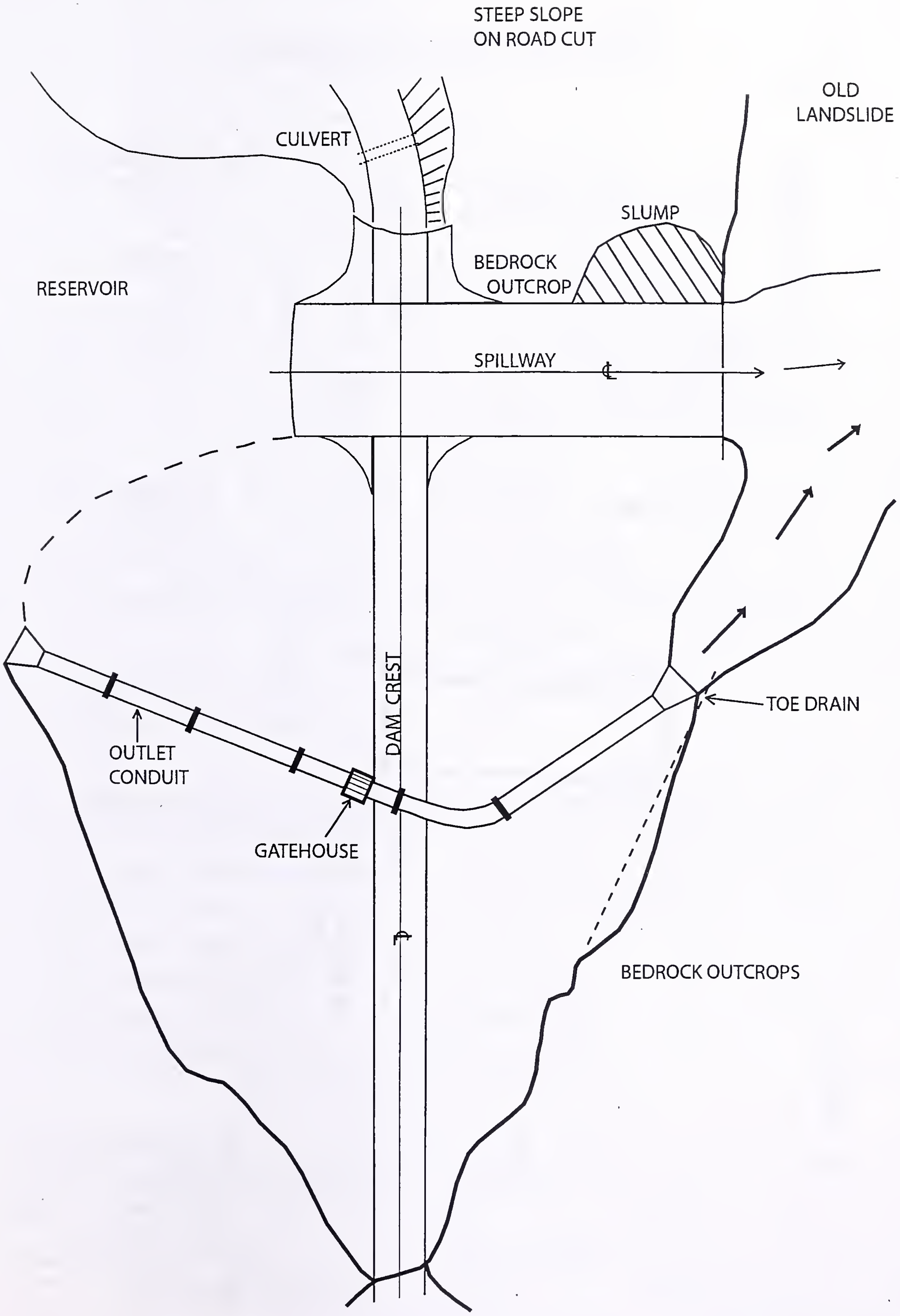

Figure 3. Bearpaw Dam General Layout

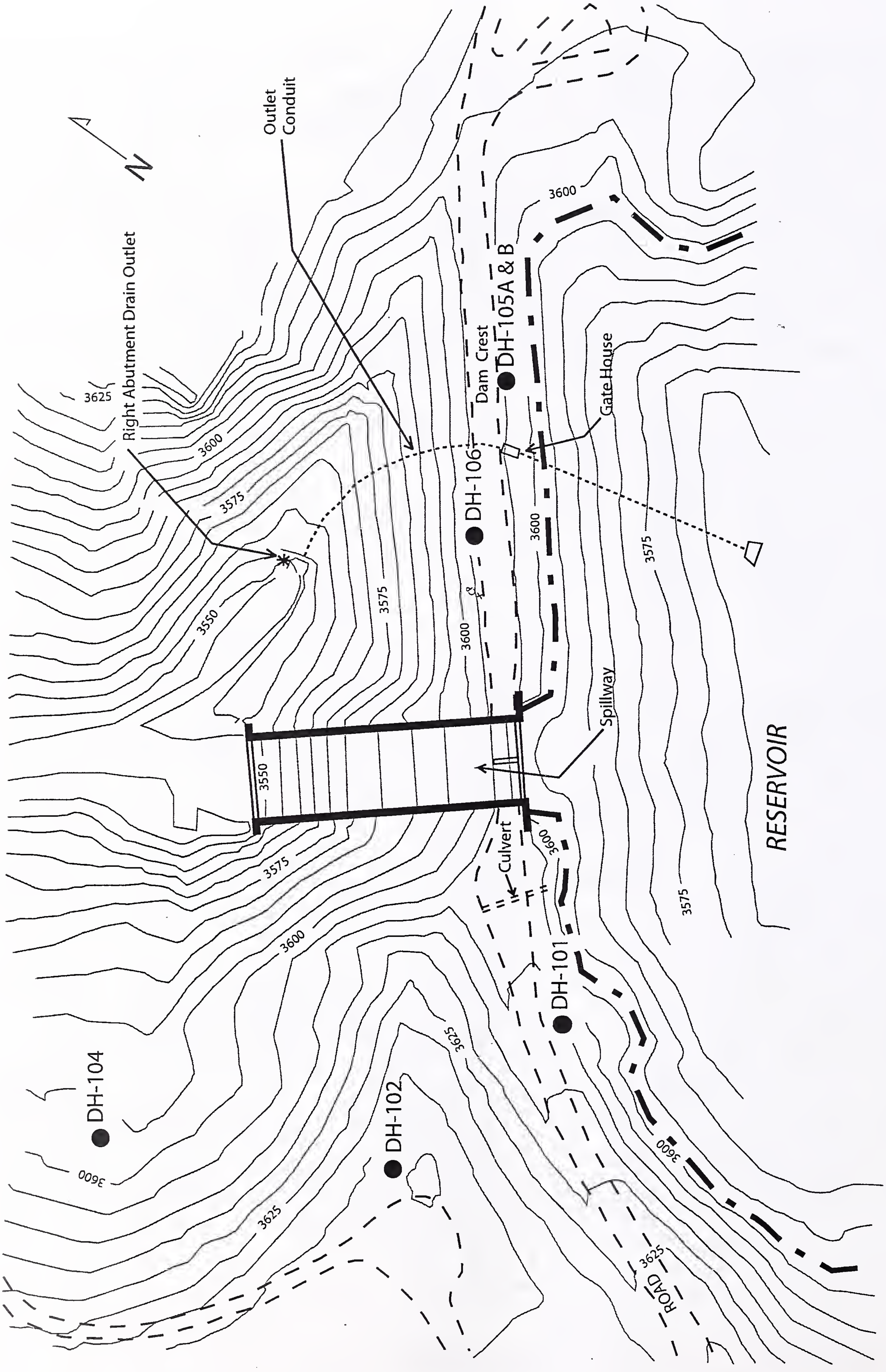

Figure 4. Bearpaw Dam Monitoring Wells Location

STATISTICAL INFORMATION

1. General

a. Owner	Montana Department of Fish, Wildlife, and Parks (DFWP)
b. Operator	Montana Department of Fish, Wildlife and Parks
c. Location	NW ¼, SE ¼, Sections 28, Township 30 North, Range 16 East, Montana Principal Meridian, 20 miles southeast of Havre
d. Latitude Longitude	48.328° 109.658°
e. County--State	Hill - Montana
f. Watershed Location	Beaver Creek, Tributary of Milk River
g. Drainage Area	50.6 square miles
h. Year Constructed	1958

2. Principal Elevations (feet above mean sea level)

a. Top of Barrier Parapet Wall	3,608.7 feet
b. Top of Grate (Gatehouse)	3,606.5 feet
c. Dam Crest	3,606.0 feet
d. Brass Cap by Spillway	3,605.53 feet
d. Spillway Crest	3,598.0 feet
e. Normal Full Pool	3,598.0 feet
f. Outlet at Toe of Dam	3,547.3 feet

3. Reservoir

a. Length of Maximum Pool (approximately)	3/4 mile
b. Surface Area (at normal full pool)	35.7 acres

4. Storage

a. Total Storage (pool at dam crest)	1,005 acre-feet
b. Active Storage (pool at spillway crest)	616 acre-feet
c. Maximum Surcharge	389 acre-feet

5. Hydrology

a. Inflow Design Flood	4,000 cfs
b. 100 Yr Flood	1,840 cfs
c. 500 Yr Flood	4,100 cfs

6. Embankment (Dam)

a. Type	Earthfill
b. Hydraulic Height	59 feet from outlet
c. Structural Height	64 feet from core trench
d. Crest Length	380 feet
e. Crest Width	18 to 20 feet
f. Downstream Slope	1v on 2h
g. Upstream Slope	1v on 3h to 1v on 4h

7. Outlet Works

a. Size	3-feet wide at bottom, 18-inch straight sides with 18-inch curved top, reinforced concrete
b. Length	320 feet with a 60° bend from the gates to the outlet structure
c. Gate	Two 36-inch square sluice gates (one operating gate; one emergency gate) at the bottom of a vertical wet tower
d. Control	Hand crank

f. Capacity	
Reservoir at Dam Crest	170 cfs (approximate)
Reservoir at Spillway Crest	160 cfs (approximate)
f. Design Elevation	
i. Top tower grate	3606.5 feet
(lower floor elevation)	3550.0 feet
ii. Intake Structure Sill	3552.0 feet
iii. Conduit Invert (at gate chamber)	3550.0 feet
iv. Outlet Invert Sill	3547.0 feet
g. Trashrack	Yes
h. Air Vent	4-inch diameter cast iron flanged pipe exits outside gatehouse

8. Spillway

a. Location	Left abutment
b. Type	Uncontrolled concrete chute with ogee crest control
c. Width	50 feet
d. Capacity (pool at dam crest)	4,000 cfs

OPERATING PROCEDURES

Bearpaw Dam is operated by the DFWP. The primary operating goal of the reservoir is to provide an adequate supply of water for fisheries and recreation without exceeding safe storage or flow levels.

DAM OPERATOR

The responsibility for the daily operation of the dam and reservoir rests with the DFWP and its dam operator. The dam operator is generally authorized to operate the reservoir to meet the DFWP's goals. The dam operator's specific responsibilities are to:

1. Operate the mechanical features of the outlet works
2. Coordinate filling of the reservoir and the release of water
3. Measure monitoring wells and observe seepage
4. Notify the SWPB and DFWP of unusual occurrences such as impending floods, or excessive seepage.
5. Notify the SWPB and DFWP when spring runoff flows have peaked.
6. Perform maintenance tasks.

Typically, the out-going dam operator will train a new operator. The operator's training focuses on the mechanical operation of the gates, measurement of the storage level, measurement of the rate of water release, measure the monitoring wells and record keeping.

The dam operator normally is available to observe the dam and perform operating functions as needed when the DFWP calls for their water.

Communication between the dam operator, DFWP and SWPB is by telephone. Although not routinely available, radio communication may be established during emergencies or unusual occurrences, so the dam operator can speak directly with the SWPB **(see the Bearpaw Dam Emergency Action Plan)**. The SWPB will notify DFWP.

METHOD AND SCHEDULE OF OPERATION

The reservoir is operated for the purpose of maintaining the fishery and for recreation. The normal reservoir pool is maintained at or near the spillway crest year-round. During high runoff, higher pool levels may occur for short periods of time. The gate is usually closed or nearly closed and most inflow water is passed over the spillway.

Releases are seldom made from storage for irrigation, flood control, or other consumptive uses. When directed by the fishery biologist, releases may be made from the cooler bottom waters. These releases usually occur in late summer to help enhance the fishery below the reservoir.

GATE OPERATION

The maximum capacity of the outlet conduit with the reservoir at the dam crest is about 170 cfs. With the pool at the spillway crest, the capacity of the outlet works is about 160 cfs. The recommended maximum sustainable outflow through the low level outlet works is 160 cfs. The outlet works are intended to be used for controlling the release of water for fisheries, and not for providing emergency flood relief.

The gates are operated manually with a hand crank. The maximum gate opening for either gate is 37 inches. The amount a gate is opened is measured on the exposed portion of the gate stem between the top of the pedestal and the bottom of the stop nut. Opening a gate in excess of this amount may damage the gate, gate frame, gate stem or the gate pedestal. Also, a gate should not be "forced" using the low speed crank. Forcing a gate may bend the stem and may damage the gate mechanism.

The upstream "emergency" gate should remain fully open at all times, except for annual operation, inspections or gate repair. During inspections or gate repair, the emergency gate can be closed to shut off water to the downstream "operating" gate.

SPILLWAY

With the reservoir at the dam's crest, the maximum capacity of the spillway using a head-discharge relationship is 4,000 cfs. A rating curve for the spillway is included in Appendix A.

Most water inflowing to the reservoir is normally passed over the spillway. When water exceeds one foot in depth over the spillway, the outlet works should be opened to control further rise in stage, if possible.

SAFE DRAWDOWN

To ensure stability of the upstream embankments, it is recommended that reservoir draw down not exceed one foot per day. This recommended rate should not be exceeded without the approval of the SWPB.

An analysis of the rapid drawdown stability of the dam was preformed by HKM (Billings) in 1994. Their analysis found a factor of safety of 1.68 which is significantly greater than the recommended minimum of 1.2. However, they noted that drawdown rate should still be restricted to prevent slope failure around the reservoir perimeter.

STORAGE DETERMINATION

Storage in the reservoir and the elevation of the reservoir surface are determined by taking a slope measurement. Measure in feet from the 0+00 pin to the water surface. The 0+00 pin is located at the north end of the first picnic area upstream from the dam on the west bank of the reservoir. Once the slope measurement is determined, the elevation of the reservoir surface and the storage can then be found using the Slope-Elevation-Storage Table (Table 1) in Appendix A.

If no water is being released through the outlet conduit, the reservoir elevation and storage can be determined by measuring the water level in the gate tower. Measure from the top of the grate in the gatehouse to the water surface. The top of grate elevation is 3,606.5 feet. Subtract the vertical distance from the grate to the water surface from 3,606.5 to find the elevation of the water surface. Once the reservoir surface elevation is determined, the reservoir storage is found using the Elevation/Storage Table (Table 2) in Appendix A.

INFLOW AND OUTFLOW MONITORING

There are no inflow or outflow monitoring sites for Bearpaw Dam.

WEATHER MONITORING

The dam operator monitors weather conditions, local weather forecasts, and the National Weather Service (NWS).

If severe flooding is anticipated, the NWS Great Falls Office **(1-800-453-2081 or 406-453-4561)** should be requested to make “forecast points” of flows. If this request is adopted, NWS will provide peak flow, storm duration, runoff duration (above base flow), and total volume flood forecast for this stream gauge as conditions warrant.

SNOTEL Sites: Current snow water equivalent and total precipitation can be monitored at a SNOTEL site located above the reservoir -- Rocky Boy. The information for this site can be accessed under the St. Mary and Milk River Basin portion of the following USDA internet site:

ftp://ftp.wcc.nrcs.usda.gov/data/snow/update/mt.txt

Additional information about historical snowpack, precipitation, maps and graphs can be accessed at the following internet site:

http://www.mt.nrcs.usda.gov/snow/

INTERACTION WITH OTHER DAMS

East Fork Dam is located above Bearpaw Reservoir. The earth-fill dam is 45 feet high with a crest length of 180 feet. The dam has a storage of 54 acre feet to the crest of the auxiliary spillway and 111 acre feet to the crest of the dam. If the dam were to breach, the maximum of 111 acre feet would easily be contained in the 389 acre feet surcharge available in the Bearpaw reservoir.

Beaver Creek Dam is an earthfill embankment located about 10 miles below Bearpaw Dam on Beaver Creek. The reservoir stores 6,270 acre feet at the principal spillway crest. The safety of Beaver Creek Dam is not effected by the normal operation of Bearpaw Dam.

EMERGENCEY

If it appears that the Bearpaw Dam is about to breach, or during emergency operations, the dam operator will initiate the **Bearpaw Dam Emergency Action Plan.**

INSPECTION AND MONITORING

The SWPB inspects the dam annually. Appendix B includes an example of a SWPB inspection report form. In addition to annual inspections, SWPB Havre Regional Office personnel or the dam operator will inspect the dam and reservoir during and after heavy runoff, severe rainstorms and severe windstorms; during high storage periods; and after an earthquake. The embankment is monitored by instrumentation.

STRUCTURAL FEATURES INSPECTION

Structural features include the outlet works, bridge, gatehouse, spillway, and dam embankment. The SWPB inspects these structures annually as part of its inspection program. Items to be checked or noted include, but are not limited to, the following:

1. Outlet Works
    a. Any differential settlement or movement resulting in cracking of the conduit
    b. Erosion of the seals or concrete by cavitation immediately downstream of the gates
    c. Major seepage of water into the conduit
    d. Deterioration of exposed concrete due to freeze/thaw cycles or sulfate reactions
    e. Operation of both gates
    f. Air vent for free, unobstructed operation
    g. All metal for corrosion
2. Gate House
    a. Any damage or vandalism

3. Spillway
    1. Erosion of the spillway channel
    2. Blockage of the approach or exit channel
    3. Concrete condition
    4. Stilling basin
    5. Condition of the fence along spillway and stilling basin walls
4. Embankment
    1. Erosion
    2. Settlement, bulges, sink holes, cracking, misalignment
    3. Riprap displacement
    4. Damage from burrowing animals
    5. Excessive vegetation, brush, trees
    6. Seepage
    7. Condition of the road across the dam
5. Bridge
    1. Deterioration of bridge surface
    2. Corrosion of steel
    3. Major structural cracking of wingwalls or abutment walls
    4. Deterioration of bearing pads
    5. Deterioration of concrete bridge support piers

RIPRAP INSPECTION

The riprap along the face of the dam should measure at least 18-inchs thick. Immediately after the occurrence of high water, the riprap should be inspected and additional riprap added if needed.

DRAINS

Right Abutment: There is a 8-inch pipe drain along the toe of dam in the right abutment. The drain follows the cut-off trench trough of the downstream toe from the right abutment to the outlet conduit, and exits just downstream from the outlet conduit.

Spillway: There is a 6-inch drain pipe system installed in gravel-sand filters under the spillway floor. The spillway drains exit into the downstream channel at four points along the downstream side of the flip bucket. See drawing S1 in Appendix E for a layout of the drain system.

Left Abutment Road Drain: The is a 4-inch drain in the left abutment which parallels the downstream toe of the access road. The drain exits over the top of the spillway wall into the upper portion of the spillway. The drain was added because of a slump area on the upstream side of the access road near Drill Hole 101.

SEEPAGE

There are no reported or visible seepage areas on the dam embankment or below the dam embankment. There are drain pipes located under the spillway floor and outside the left spillway wall. There has been observable water flow from the drain outside the left spillway wall. Also, the left abutment road drain has been observed to flow periodically.

MONITORING WELLS

The 1955 construction drawings for the dam show several exploratory drill holes. The holes were apparently destroyed during the construction of the dam in 1958.

As part of a feasibility study to determine the work necessary to bring the dam up to present dam safety standards, a drilling program was performed in 1991 to identify the soil profile and characteristics. Seven borings were made on and around the dam, and monitoring tubes were placed in five of the drill holes. The location of the monitoring wells is shown in Figure 4. Copies of the well logs is in Appendix D.

SEEPAGE MONITORING

The monitoring wells and drains at the dam are observed and monitored by the dam operator and may be measured by the SWPB during annual inspections. The instruments are generally measured once per month. The monitoring data is maintained by the SWPB in Helena.

EMBANKMENT MONITORING POINTS

There are no monitoring measurement points on the dam embankment.

There are 11 monitoring measurement points located in the left abutment in and around a landslide area. Eight monitoring points are established in the landslide downstream from the spillway in the left abutment, and three points are in the slump area adjacent to the spillway in the left abutment. See Project Drawings (Appendix E) for location of monitoring points.

MAINTENANCE

The DFWP are responsible for the routine maintenance of the project. In addition, the SWPB may identify items that need maintenance or repair during the annual inspection.

ROUTINE MAINTENANCE

To protect the dam and keep it in good working order, the dam operator during regular visits to the dam will watch for and identify any potential maintenance requirements. As soon as a need is identified, the dam operator will contact the DFWP to schedule and perform the routine maintenance.

Items that may need occasional attention include, but are not limited to:

1. *Lubrication and cleaning of gate-operating mechanisms.*
2. *Debris or silt plugging the spillway inlet, bridge pier or the outlet channel.* Accumulated debris that could affect the operation of these appurtenances should be removed at once.
3. *Erosion gullies on embankment.* Erosion gullies should be checked immediately. Gullies should be filled, compacted, and seeded. Particular attention should be paid to the groin/abutment contact areas.
4. *Rodent damage.* Rodents will be removed or destroyed, and any burrow holes should be filled immediately.
5. *Riprap.* The upstream face riprap normally will be observed annually, but may occasionally need repairs because of high water or wave action. Riprap below spillway and outlet works may need repairs.
6. *Vegetative cover on downstream slope.* Good vegetative cover must be maintained. Large brush and any trees should be removed.

7. *Noxious weeds.* Noxious weeds on and around the dam embankment and around the reservoir shall be sprayed at least on an annual basis.
8. *Cleaning spillway wall tops.* Spillway wall tops should be clear of any dirt, rocks, grass, brush, and any overhanging vegetation or trees.
9. *Repair of the spillway.* The sealing of joints and cracks in the spillway floor, walls, and flip bucket.

ANNUAL MAINTENANCE

The SWPB conducts annual inspections of Bearpaw Dam and reservoir. During these inspections, any items requiring annual maintenance will be identified and recorded. Items that may need annual maintenance are the dam embankment, outlet works, gates, gatehouse, air vent structure, spillway, and riprap.

After the inspection, the SWPB sends the DFWP Helena Office a Dam Safety Inspection Report and a Maintenance Report. The reports identify items that need maintenance and provides a schedule of when the maintenance tasks need to be completed. The DFWP is responsible for performing the maintenance items within the times specified.

The DFWP may perform the maintenance tasks. However, major repair's will likely to be handled by a contractor. The SWPB may assist in contracting for repairs and may supervise the repair work.

RECORD-KEEPING

The SWPB maintains records, including photographs, of all inspections and maintenance requirements. These records also include flow measurements and storage volumes. Anyone who wants to review these records may do so in the SWPB's office at the Department of Natural Resources and Conservation in Helena.

The dam operator will keep records of the reservoir elevation, seepage observation or measurements, and any unusual conditions. These records may be reviewed at the dam operators home.

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APPENDICES

APPENDIX A
RATING CURVES AND TABLES

TABLE 1. SLOPE- ELEVATION-STORAGE TABLE

BEARPAW RESERVOIR

Spillway Crest = 3.598.0 feet
Dam Crest = 3,606.0 feet

Based on survey of October 10, 2001 by Marvin Cross and Kraig VanVoast.

The upper and lower pins are located at the north end of the first picnic area upstream from the dam on the west bank of the reservoir.

DISTANCE feet	ELEVATION feet	STORAGE acre-feet
Upper Pin		
Pin 0+00	3614.69	1621
1	3614.32	1595
2	3613.96	1570
3	3613.59	1543
4	3613.26	1520
5	3612.92	1496
6	3612.59	1472
7	3612.26	1449
8	3611.93	1426
9	3611.60	1402
10	3611.25	1377
11	3610.91	1354
12	3610.56	1327
13	3610.25	1306
14	3609.94	1285
15	3609.63	1262
16	3609.26	1236
17	3608.90	1211
18	3608.53	1184
19	3608.26	1165
20	3608.00	1147
21	3607.73	1127
22	3607.41	1105
23	3607.08	1082
24	3606.76	1058
25	3606.43	1035
26	3606.11	1013
27	3605.78	993
28	3605.50	978
29	3605.22	963
30	3604.94	948
31	3604.70	935
32	3604.46	923
33	3604.22	910
34	3603.97	894
35	3603.72	883
36	3603.47	870
37	3603.27	860
38	3603.06	848
39	3602.86	838
40	3602.67	828
41	3602.47	817
42	3602.28	807
43	3602.16	800
44	3602.05	794
45	3601.93	788
46	3601.66	774
47	3601.39	759
48	3601.12	745
49	3601.00	739
50	3600.87	734
51	3600.75	728
52	3600.56	720
53	3600.38	713
54	3600.19	706
55	3600.04	700
56	3599.89	694
57	3599.74	688
58	3599.65	684
58.8	3599.55	680
DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE- ELEVATION-STORAGE TABLE (continued)
BEARPAW RESERVOIR

DISTANCE feet	ELEVATION feet	STORAGE acre-feet
Lower Pin		
Pin 0+00	3599.55	680
1	3599.50	677
2	3599.45	675
3	3599.40	673
4	3599.35	671
5	3599.31	669
6	3599.26	668
7	3599.26	668
8	3599.25	667
9	3599.25	667
10	3599.24	666
11	3599.24	666
12	3599.23	666
13	3599.21	665
14	3599.20	665
15	3599.18	664
16	3599.14	663
17	3599.11	661
18	3599.07	660
19	3599.02	658
20	3598.97	656
21	3598.92	652
22	3598.83	650
23	3598.73	646
24	3598.64	642
25	3598.56	639
26	3598.49	637
27	3598.41	633
28	3598.15	622
29	3597.90	613
30	3597.64	604
31	3597.57	601
32	3597.37	594
33	3597.03	582
34	3596.95	579
35	3596.84	576
36	3596.74	572
37	3596.59	566
38	3596.44	561
39	3596.23	553
40	3596.08	548
41	3595.95	543
42	3595.74	536
43	3595.48	528
44	3595.30	522
45	3595.16	518
46	3594.98	512
47	3594.78	505
48	3594.55	498
49	3594.30	490
50	3594.09	484
51	3593.82	475
52	3593.54	465
53	3593.30	458
54	3593.14	449
55	3592.98	447
56	3592.80	442
57	3592.53	433
58	3592.41	429
59	3592.22	423
60	3592.08	418
61	3591.94	414
62	3591.83	410
63	3591.66	405
64	3591.53	401
65	3591.35	394
66	3591.20	390
67	3591.02	384
68	3590.86	380
DISTANCE	ELEVATION	STORAGE

TABLE 2. ACTIVE STORAGE IN ACRE-FEET

BEARPAW DAM

Elevation	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
3551	0.0									
3552	0.1									
3553	0.3									
3554	0.4									
3555	0.6									
3556	0.7									
3557	1	1	2	2	2	2	2	2	2	2
3558	2	2	2	2	2	2	3	3	3	3
3559	3	3	3	3	3	3	3	3	3	3
3560	4	4	4	4	4	4	4	4	4	4
3561	4	5	5	5	5	6	6	6	7	7
3562	7	8	8	8	8	9	9	9	10	10
3563	10	11	11	11	12	12	12	12	13	13
3564	13	14	14	14	15	15	15	15	16	16
3565	16	17	17	17	18	18	18	18	19	19
3566	19	20	21	21	22	23	23	24	24	25
3567	26	26	27	28	28	29	29	30	31	31
3568	32	33	33	34	35	35	36	36	37	38
3569	38	39	40	40	41	41	42	43	43	44
3570	45	45	46	47	47	48	48	49	50	50
3571	51	52	53	54	55	56	57	58	59	60
3572	61	62	63	64	65	66	67	68	69	70
3573	71	72	73	74	75	76	77	78	79	80
3574	81	82	82	83	84	85	86	87	88	89
3575	90	91	92	93	94	95	96	97	98	99
3576	100	102	103	104	106	107	109	110	111	113
3577	114	116	117	118	120	121	122	124	125	127
3578	128	129	131	132	134	135	136	138	139	141
3579	142	143	145	146	147	149	150	152	153	154
3580	156	157	159	160	161	163	164	166	167	168
3581	170	172	173	175	177	179	181	183	185	186
3582	188	190	192	194	196	198	199	201	203	205
3583	207	209	211	212	214	216	218	220	222	224
3584	226	227	229	231	233	235	237	239	240	242
3585	244	246	248	250	252	253	255	257	259	261
3586	263	265	268	270	272	275	277	280	282	284
3587	287	289	292	294	297	299	301	304	306	309
3588	311	313	316	318	321	323	325	328	330	333
3589	335	338	340	342	345	347	350	352	354	357
3590	359	362	364	367	369	371	374	376	379	381
3591	383	387	390	393	396	400	403	406	409	412
3592	416	419	422	425	429	432	435	438	442	445
3593	448	451	454	458	461	464	467	471	474	477
3594	480	484	487	490	493	496	500	503	506	509
3595	513	516	519	522	526	529	532	535	538	542

TABLE 2. ACTIVE STORAGE IN ACRE-FEET (continued)

BEARPAW DAM

Elevation	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
3596	545	549	552	556	559	563	566	570	574	577
3597	581	584	588	591	595	598	602	606	609	613
3598	616	620	624	629	633	637	641	645	649	653
3599	657	661	665	669	673	677	682	686	690	694
3600	698	702	706	710	714	718	722	726	730	735
3601	739	744	749	755	760	765	771	776	781	786
3602	792	797	802	808	813	818	824	829	834	840
3603	845	850	856	861	866	872	877	882	888	893
3604	898	904	909	914	920	925	930	935	941	946
3605	951	957	962	967	973	978	983	989	994	999
3606	1005	1012	1019	1026	1033	1040	1047	1054	1061	1069
3607	1076	1083	1090	1097	1104	1111	1118	1125	1132	1140
3608	1147	1154	1161	1168	1175	1182	1189	1196	1203	1211
3609	1218	1225	1232	1239	1246	1253	1260	1267	1274	1282
3610	1289	1296	1303	1310	1317	1324	1331	1338	1345	1353
3611	1360	1367	1374	1381	1388	1395	1402	1409	1416	1424
3612	1431	1438	1445	1452	1459	1466	1473	1480	1487	1495
3613	1502	1509	1516	1523	1530	1537	1544	1551	1558	1566
3614	1573	1580	1587	1594	1601	1608	1615	1622	1629	1637
3615	1644	1651	1658	1665	1672	1679	1686	1693	1700	1708
3616	1715									

NOTE: Storage table data from HKM Design and Construction Report, dated 1/1996.

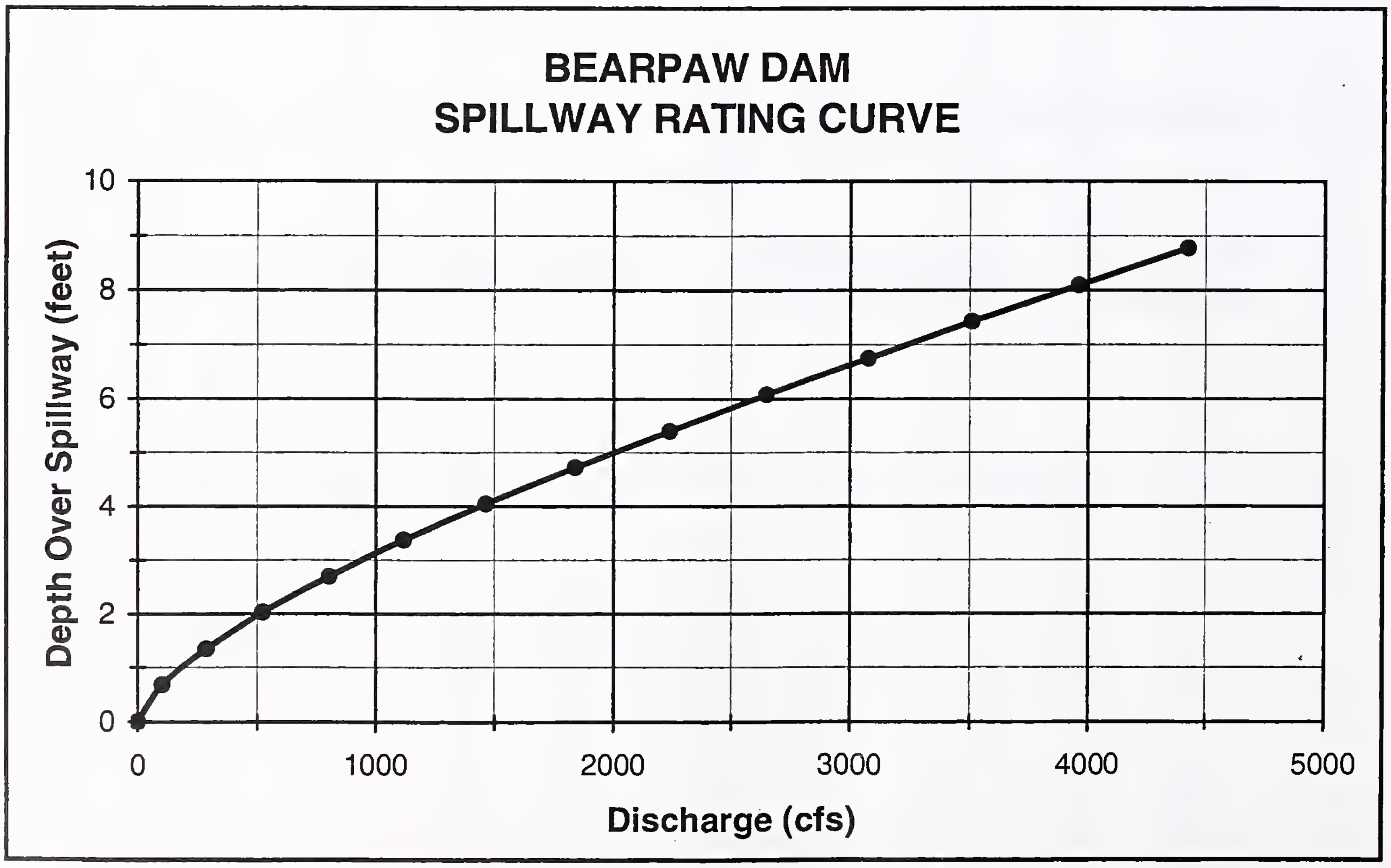
Top of Grate (gatehouse): Elevation 3,606.5 feet

Spillway Crest	Elevation 3598.0 feet	Storage 616 acre-feet
Dam Crest	Elevation 3606.0 feet	Storage 1005 acre-feet

TABLE 3. SPILLWAY DISCHARGE

BEARPAW DAM

Depth Over Crest (feet)	Elevation (feet)	Discharge (cfs)
0.00	3598.00	0
0.68	3598.68	101
1.35	3599.35	285
2.03	3600.03	522
2.70	3600.70	801
3.38	3601.38	1116
4.05	3602.05	1463
4.73	3602.73	1838
5.40	3603.40	2238
6.08	3604.08	2649
6.75	3604.75	3077
7.43	3605.43	3510
8.10	3606.10	3959
8.78	3606.78	4422



Note: Data from HKM Design and Construction Report (1/1996).

APPENDIX B

INSPECTION CHECKLIST

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
DAM SAFETY INSPECTION REPORT

NAME OF DAM
DATE INSPECTED

INVENTORY NO. ______________
HAZARD CATEGORY __________
TYPE OF DAM ________________
YEAR BUILT __________________

OWNER ________________________
OPERATOR _____________________
STREAM _______________________
DRAINAGE AREA ________________

Reservoir Storage Status

	Water Surface Elevation (feet)	Storage (acre-feet)
At time of inspection		
At spillway crest		
At min. dam crest elevation		

ITEM	YES	NO	REMARKS

1. EMBANKMENT

A. Crest -- Height= Length= Width=

(1) Any visual settlements?			
(2) Any misalignments?			
(3) Any cracking?			
(4) Any traffic damage?			
(5) Other?			

ITEM	YES	NO	REMARKS

1. **EMBANKMENT** (continued)

B. Upstream Face -- Slope=

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Is riprap protection adequate?			
(5) Any stone deterioration?			
(6) Any visual settlement, slumps, sloughing, depressions or bulges?			
(7) Adequate grass cover?			
(8) Debris on the dam face?			
(9) Other?			

C. Downstream Face--Slope=

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Any visual settlement, slumps, sloughing, depressions or bulges?			
(5) Is the toe drain dry?			
(6) Are the relief wells flowing?			
(7) Any boils at the toe?			
(8) Any seepage areas?			
(9) Any traffic or animal damage?			
(10) Any burrowing animals?			
(11) Adequate grass cover?			
(12) Other?			

D. Amount and Type of Vegetation on the Dam

ITEM	YES	NO	REMARKS

2. ABUTMENT CONTACTS

A) Any erosion?			
B) Any visual differential movement?			
C) Any cracks?			
D) Any seepage present?			
E) Other?			

3. OUTLET WORKS

A. Intake Structure -- Size=

(1) Any settlement?			
(2) Any tilting?			
(3) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(4) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(5) Metal appurtenances:			
a. Any corrosion present?			
b. Any breakage present?			
(6) Trash rack?			
a. Condition?			
b. Anchor system secure?			
(7) Other?			

ITEM	YES	NO	REMARKS

3. OUTLET WORKS (continued)

B. Conduit -- Type =   Size =

(1) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(3) Is the conduit metal?			
a. Any corrosion present?			
b. Protective coatings adequate?			
(4) Is the conduit misaligned?			
(5) Any calcium deposits?			
(6) Other?			

C. Gates and Tower

(1) Gates:			
a. Size: Operating: b. Type: Operating:	Emergency: Emergency:		
(2) Controls operational?			
(3) Controls lubricated?			
(4) Operational problems?			
(5) Leakage around gates?			
(6) Condition of gate seals?			
(7) Any cavitation damage? If so, describe?			
(8) Describe air vent-size and condition.			

ITEM	YES	NO	REMARKS

3. OUTLET WORKS (continued)

C. Gates and Tower (continued)

(9) Is there a jet pump?			
a. Is it operational?			
b. Leakage?			
(10) Is the tower dry? ____ wet?			
(11) Any seepage in the tower?			
(12) Condition of the tower?			
(13) Any safety problems?			
(14) Ladder in good condition?			
(15) Condition of the gatehouse?			
(16) Emergency plan completed for the dam?			
a. Posted in the gatehouse?			
(17) Other?			

D. Stilling Basin

(1) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
b. Leakage?			
(3) Do energy dissipaters show:			
a. Signs of deterioration?			
b. Are they covered with debris?			
(4) Other?			

ITEM	YES	NO	REMARKS

3. OUTLET WORKS (continued)

E. Downstream Channel

(1) Is the channel:			
a. Eroding or backcutting?			
b. Sloughing?			
c. Obstructed?			
(2) Is released water:			
a. Undercutting the outlet?			
b. Eroding the embankment?			
(3) Other?			

4. SPILLWAY

A. Description

(1) Location?			
(2) Type of Spillway?			
(3) Size of Spillway?			
(4) Spillway lining?			
(5) Is there a weir?			
(6) Is the spillway in good condition?			
(7) Any drains?			
a. Describe the condition of drains.			

B. Does spillway show:

(1) Any cracking concrete?			
(2) Any spalling concrete?			
(3) Any exposed reinforcement in the concrete?			
(4) Any erosion?			

ITEM	YES	NO	REMARKS

4. SPILLWAY (continued)

4. B. Does spillway show: (continued)

(5) Any slope sloughing?			
(6) Any obstructions?			
(7) Displacement or offset joints?			
(8) Loss of joint material?			
(9) Leakage at the joints?			
(10) Other?			

C. Do the energy dissipaters show:

(1) Signs of deterioration?			
(2) Any cracking?			
(3) Any spalling?			
(4) Any exposed reinforcement?			
(5) Are they covered with debris?			
(6) Other?			

D. Has release water:

(1) Eroded the embankment?			
(2) Undercut the outlet?			
(3) Eroded the downstream channel?			
(4) Other?			

E. Emergency Spillway

(1) Is there an emergency spillway?			(If YES, describe)

ITEM	YES	NO	REMARKS

5. RESERVOIR CONTROL

A) Recent upstream development?			
B) Recent downstream development?			
C) Slides in reservoir area?			
D) Change in reservoir operation?			
E) Large impoundment upstream?			
F) Any debris in the reservoir?			
G) Other?			

6. INSTRUMENTATION

A) List type(s) of instrumentation:			
B) In good condition?			
C) Read periodically?			
D) Is data available?			
E) Include all data gathered since last report.			

7. DOWNSTREAM CONDITION

A. Downstream Land Use.

This dam was inspected by:

Additional comments and recommendations.

APPENXI C

DISTRUBUTION LIST

BEARPAW DAM O&M DISTRUBUTION LIST

	Number Of Copies
1. State Water Projects Bureau Kevin Smith Rob Kingery FW&Ps Engineer (vacant) Art Taylor (2) Bob Arrington Dolores Eustice	7
2. DNRC Information Services Section	1
3 DNRC Havre Regional Office Bob Larson Marvin Cross	2
4. DNRC Dam Saftey	1
5. Dam Operator Dam Operator (Kent Gilge - FW&Ps Havre) Gate house	2
6. Department of Fish, Wildlife, and Parks Dale Carlson – Glendive, Park Operations Specialist Paul Valle – Helena – Design & Construction Bureau Chief Ken Phillips – Helena – Design & Construction Bureau	3
7. State Library – Attn: Roberta Gebhart	4
8. Extra	2
TOTAL	22

APPENXI D

MONITORING WELL LOGS

TEST HOLE LOG

PROJECT: Bearpaw Dam

HOLE NO.: DH 101

DATE: 6-27-91

TEST HOLE LOCATION: Approximately 130' west of new bridge along access road (left abutment), near old slump area

ELEVATION G.S.: Approx. 3612

TOTAL DEPTH: 40'

GROUNDWATER LEVEL: 23'

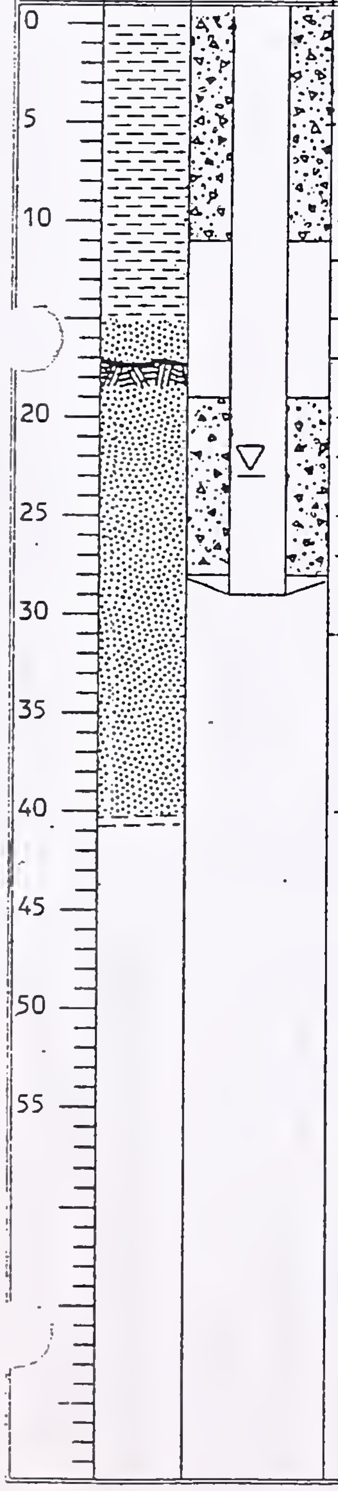
MEASURED FROM: Ground surface

DRILL TYPE: CME55

DRILLER: RBG-Hartley

LOGGED BY: Womack

DEPTH IN FEET / GRAPHICAL LOG / WELL COMPLETION



SAMPLE	SPT (N) BLOWS/FT	RECOVERY (%)	MOISTURE CONTENT (%)	HYDRAULIC CONDUCTIVITY (FT/DAY)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION
D1	11	67			3.0	
U1		100			2.5	
D2	19	72			2.3-2.0	CL
				0.02		
D3	50 - 2.5"	88		0.004		
D4	50 - 2.0"	100		0.009		
D5	50 - 4.0"	100		0.29/0.38		
D6	Set 50 - 2.0"	100		0.04		
D7	50 - 3.5"	100				

DESCRIPTION AND REMARKS

Road mix at surface, rotary (NX), with water. Soft clay, thin gravel lens 4.5-5.0', standard sampler

D1: Moist, dark yellowish brown streaked dark grayish brown, stiff, stratified, sandy CLAY, scattered angular gravels; fill

U1: 2' push from 7.5'. As above, no streaks, yellowish brown, sandy CLAY, gravels subrounded; probably till

D2: As above to 11.0'

10.5': As above at D1, layered, probably till, slightly silty CLAY, no sand or gravel (D2A: sandy 9.5-10.5, D2: clay 10.5-11.0')

Perc test 10-15' - reddish coarse sand in very end of D2, appears in cutting 10-15'

D3: Wet, dark reddish brown, very dense, slightly clayey coarse, medium and fine SAND, numerous fine to medium gravels; probably till

Last few inches slightly moist, dark bluish gray streaked yellow, TUFF, fine to medium gravel size clasts; boulder or bedrock - slightly clayey matrix - yellow streaks on vertical joints

Perc test 15-20'

D4: As above, slightly moist, yellowish brown, very dense, clayey SAND, with coarse angular gravels; decomposed tuff

D5: Slightly moist, chocolate brown to dark reddish brown, speckled white and orange, very dense, clayey SAND with gravels as above; decomposed tuff

Drill fluid reddish below 28'

D6: As above, dark red, jointed. Switched to core at 30'. Cored 30-35' and 35-40' on 6-28-91

D7: Slightly moist, yellowish brown, hard, intact, sandy CLAY

Note: Did not drive casing below 20'

Well Completion: Open at end approximately 29'. Packer just above end, 1/4" volclay and redi-mix tamped in hole to 19'. Enviroplug medium emplaced to surface; bridged about 10-12' below surface, filled to top. Developed with bailer - +/- 30 gallons, bailed until reasonably clear. Hole measured open to 38' after pulled casing.

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Engineers and Geoscientists

CORE DESCRIPTION RECORD

Page 2 of 2

Project: Bearpaw Dam

Hole # 101

Client: DNRC

State: Montana

County:

Date: 6-27-91

Location: Bearpaw

Sec.: T: R:

Elevation:

Geologist: Womack

Driller: RBG - Hartley

Core Size: NQ

								ROCK DESCRIPTION						FRACTURE DESCRIPTION								
CORE RUN	BOX/SAMPLE #	% RECOVERY	FRAC. FREQ. (CODE)	STRENGTH (CODE)	RQD (%)	WEATHERING (CODE)		LITHOLOGY	INTERVAL	TYPE	COLOR	GRAIN SIZE	BEDDING (CODE)	INTERVAL	TYPE	DIP (DEGREES) DIRECTION	DIP (DEGREES)	SPACING (CODE)	OPENING (CODE)	SURFACE CONDITION	FILLING	COMMENTS
1	1	80	4	2	5" 2.5'	mod				Tuff	Dark red	M-1mm clasts		30.8-32 Broken zone	Jn		50	1'	N	R	Calcium carbonate gypsum	Core strong, highly fractured zones
2	1	96	4	3	0	mod				Tuff	Dark red			Very broken more scattered								End 6-27-91
3	1	68	5	5	0	decomposed				Clayey gravel	Yellowish brown	M-1mm clasts		Completely decomposed								Begin 6-28-91 Core is sub-angular rock fragments (variable lithology) in clayey sand
4	1	32	5	5	0									Completely decomposed								As above - sub-angular to sub-rounded

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TEST HOLE LOG

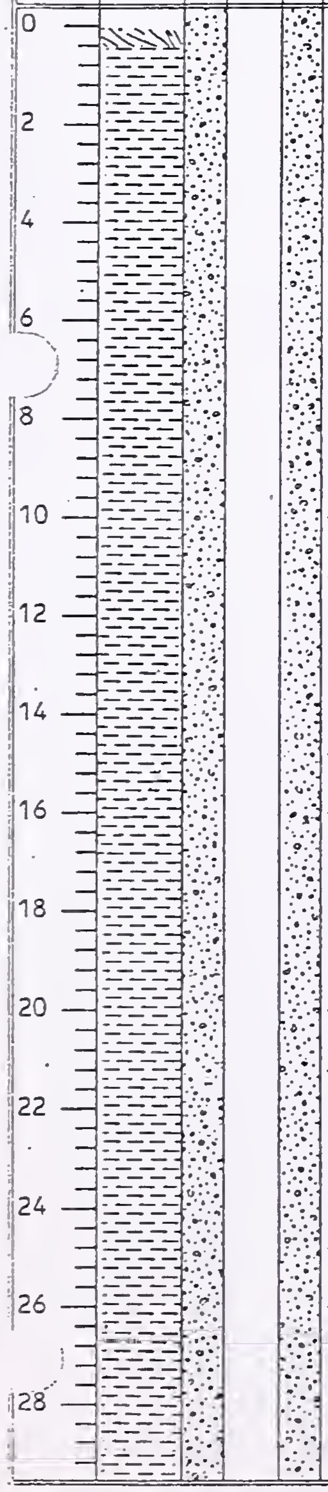
PAGE 1 OF 3

PROJECT: Bearpaw Dam
HOLE NO.: DH 102
DATE: 7-1-91

TEST HOLE LOCATION: Picnic area - high point of spillway - west end of seismic line 2/11, 25' SE of shotpoint 11R

ELEVATION G.S.: Approx. 3638
TOTAL DEPTH: Approx. 80'
GROUNDWATER LEVEL: 56.1 8-6-91
MEASURED FROM: Top of casing

DRILL TYPE: CME55 Hollow stem auger
DRILLER: RBG-Hartley
LOGGED BY: Womack



SAMPLE	SPT (N) BLOWS/FT	RECOVERY (%)	MOISTURE CONTENT (%)	HYDRAULIC CONDUCTIVITY (FT/DAY)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION AND REMARKS
							0-0.4' SOD
							0.4-3.0' Very moist, dark grayish brown, slightly sandy, silty plastic CLAY; till
							3.0' As above, yellowish brown, occasional gravels
D1	20	72	11.1		>4.5		D1: Very moist at top, becoming slightly moist, very stiff, intact, sandy CLAY, occasional fine subangular gravels; till Drills hard below 6'
D2	28	72			>4.5	CL	D2: As above, subrounded to subangular gravels, many clasts rounded
D3	28	72	11.7		>4.5		D3: As above, clasts mostly subrounded
D4	19	38			3.1		D4: As above, moisture content slightly higher, stiff, occasional black organic pieces (charcoal?)
D5	20	33	13.7				D5: As above

TEST HOLE LOG

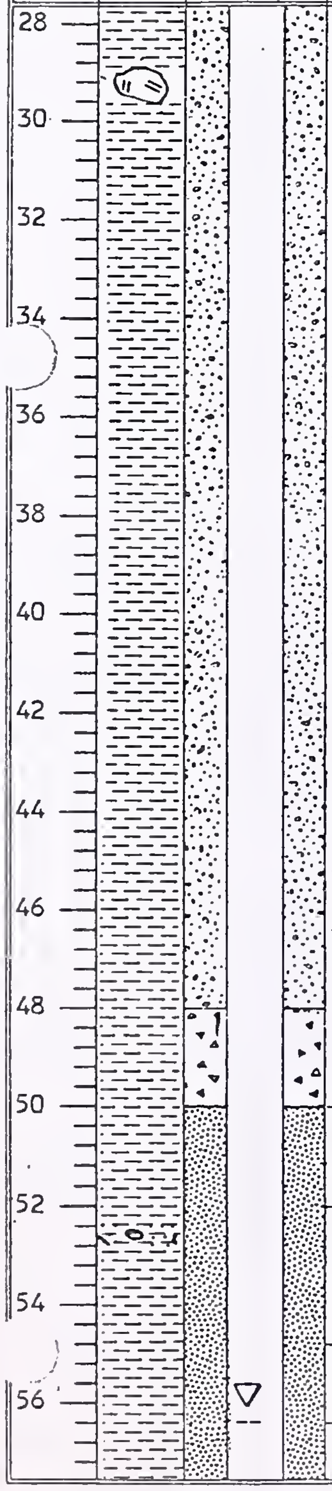
PROJECT: Bearpaw
HOLE NO.: DH 102
DATE: 7-1-91

TEST HOLE LOCATION:

ELEVATION G.S.: Approx. 3638
TOTAL DEPTH: Approx. 80'
GROUNDWATER LEVEL:
MEASURED FROM:

DRILL TYPE:
DRILLER:
LOGGED BY:

DEPTH IN FEET | GRAPHICAL LOG | WELL COMPLETION



SAMPLE	SPT (N) BLOWS/FT	RECOVERY (%)	MOISTURE CONTENT (%)	HYDRAULIC CONDUCTIVITY (FT/DAY)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION AND REMARKS
							Note: Sample rod binding somewhat, passing end of augers. Possibly affecting blow counts.
D6	50 - 1"	0					29.0' Hit rock, auger refusal, ruined shoe on sampler. Ran rock bit down the hole, cored
D7	25	100			2.0		29.0-30.0' Water drilling. Broke through into clay, boulder erratic. Core: Dark bluish gray, very strong TUFF boulders. Rotary below 29'. Pulled core barrel, ran spoon. D7: As above, moist stiff
D8	30	0					
D9	28	83	17.2		1.8		D9: Moist, dark grayish brown, stiff, intact, sandy CLAY, scattered fine subrounded gravels; till
D10	20	0					D10: Lost sampler, clay as above on outside of spoon
U1		100	17.8	0.09	2.0	CL	U1: As above, dark bluish gray, toryane 1.1 and 2.0 tsf, (rotated past stop approximately 11.1 and 12.0) (Dry density (PCF) = 109.0) Note: Drilled open hole below 50'
							Thin gravel bed 52.5'
D11	20				1.75-3.5		D11: Dropped suddenly first 6". As above, dark greenish gray, thin beds clayey sand

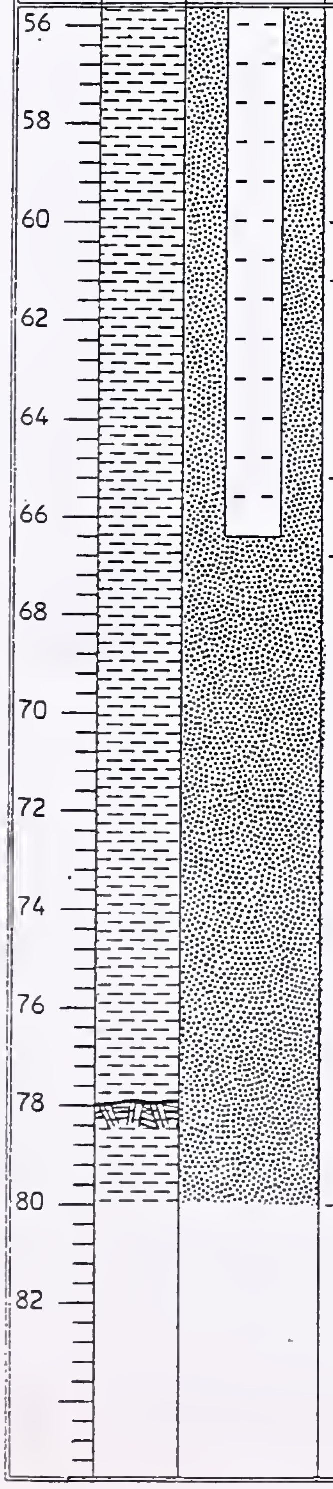
TEST HOLE LOG

PROJECT: Bearpaw Dam | HOLE NO.: DH 102 | DATE: 7-1-91

TEST HOLE LOCATION:

ELEVATION G.S.: Approx. 3638 | TOTAL DEPTH: Approx. 80' | GROUNDWATER LEVEL: | MEASURED FROM:

DRILL TYPE: | DRILLER: | LOGGED BY:



DEPTH IN FEET	SAMPLE	SPT (N) BLOWS/FT	RECOVERY (%)	MOISTURE CONTENT (%)	HYDRAULIC CONDUCTIVITY (FT/DAY)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION AND REMARKS
57					0.09			
60	D12	22	100			1.9		D12: Very moist, dark greenish gray, firm to stiff, silty plastic CLAY
66	U2		100			1.8		U2: As above, sandy, torvane 10-12.25 TSF
68								7-2-91 at 7:30AM drilled open hole to 80'. Cuttings mostly fine sand. Water changed to reddish at 68'. Then pale gray. Driller says denser at 78'. Cuttings clay with occasional very fine rock chips and lots of sand.
76								D13: Dry, dark bluish gray aphanitic pyroclastic rock. Texture sand with slight clay. contact 68-78' uncertain
78								Completion: 10-20 sand to 66.5' 10' screen, 60' blank sand to 50' 3/8" pellets to 48' 4' stickup
80	D13	50 - 4.5"						

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Engineers and Geoscientists

TEST HOLE LOG

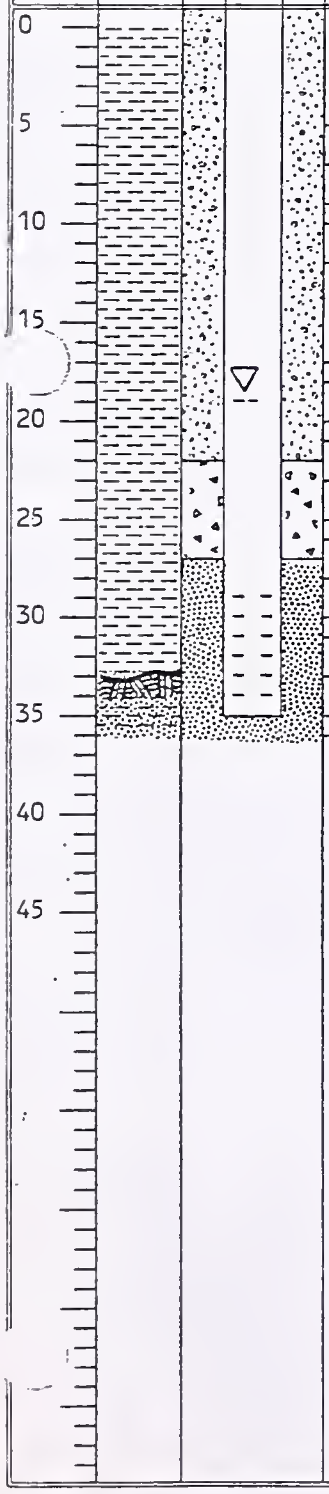
PAGE 1 OF 1

ROJECT: Bearpaw Dam
HOLE NO.: DH 104
DATE: 7-2-91

TEST HOLE LOCATION: About 10' east to TP5, west of hole DH 103

ELEVATION G.S.: Approx. 3597
TOTAL DEPTH: 35.3'
GROUNDWATER LEVEL: 19.0'
MEASURED FROM: Top of casing

DRILL TYPE: CME55 Hollow stem auger
DRILLER: RBG-Hartley
LOGGED BY: Womack



SAMPLE	SPT (N) BLOWS/FT	RECOVERY (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION AND REMARKS
							0.25' Very moist, dark grayish brown, firm, plastic, silty CLAY; slide debris
U1		57	25.0		1.4	CL	U1: Torvane 7.5-10.25 TSF
D1	9	83			0.7-1.3	CL	D1: Moist, yellowish brown, firm, plastic, silty to slightly sandy CLAY, roots near top, occasional rounded pebbles; slide debris
U2		92			0.8-1.6		U2: As above, very moist, torvane 7.0-10.25 TSF
D2	19	94	16.1		2.6		D2: As above, sandy, occasional gravel, some subangular
D3	20	100			2.2		D3: As above, moist
D4	17	100			2.0	CL	D4: As above, blue clayskins on 45 degree joints, gypsum, most clasts rounded
D5	17	100			1.5		D5: As above, very moist, firm, hit gravel at 24.5'
D6	17	100	13.8		1.7		D6: As above, dark grayish brown, coarse rounded gravel
D7	17	100			1.6		D7: As above, observed one slickensided surface, dip 45 degrees
U3		100			3.6		Pushed U3 at 30 - 1.8' (came up against something hard) U3: Appears to be wet, soft clay at top. At bottom: slightly moist, pale yellowish brown, very stiff, very sandy CLAY, torvane 9.5-12.75 TSF, end of tube is bent
D8	30	44					D8: Wet, yellowish brown, clayey SAND at top, becomes very moist, yellowish brown, very stiff, sandy CLAY, purple sandy CLAY in catcher - probably residual bedrock
D9	50 @ 4"						D9: Dry, purple, clayey SAND, becoming very weak rock

Completion:

36' casing
6' 10 slot
10-20 sand to 28' below top of casing
3/8" pellets to 26' below top of casing
enviroplug to 22.7'
cuttings to surface
stickup 1.5'

WOMACK & ASSOCIATES, INC.
Engineers and Geoscientists

TEST HOLE LOG

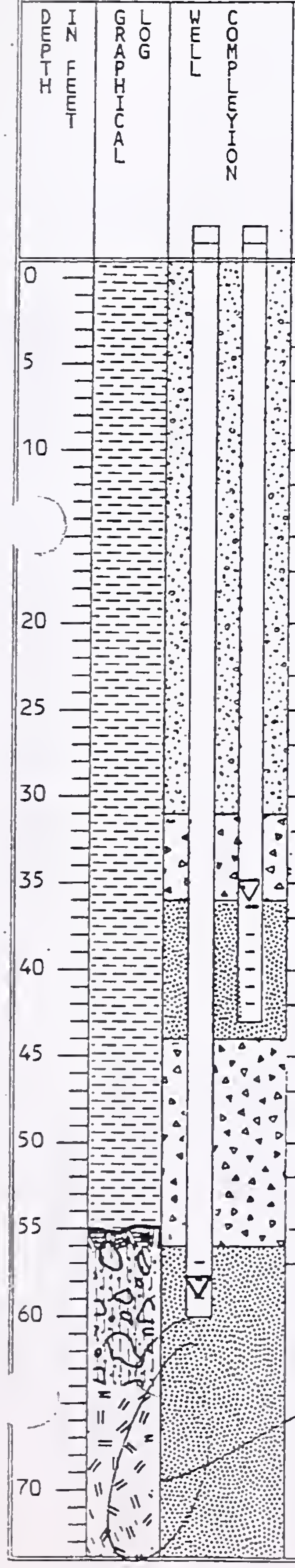
PAGE 1 OF 3

PROJECT: Bearpaw Dam
HOLE NO.: DH 105 A & B
DATE: 6-28-91

TEST HOLE LOCATION: 35' east of control house, 200' east of new bridge

ELEVATION G.S.: Approx. 3605
TOTAL DEPTH: 73.5'
GROUNDWATER LEVEL: A-36.5'
B-59.2'
MEASURED FROM: Top of casing

DRILL TYPE: CME55 Rotary
DRILLER: RBG-Hartley
LOGGED BY: Womack



SAMPLE	SPT (N) BLOWS/FT	RECOVERY (%)	MOISTURE CONTENT (%)	HYDRAULIC CONDUCTIVITY (FT/DAY)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION AND REMARKS
							0-4' Riprap and clay 4' CLAY
D1	9	63	22.8		0.75		D1: Very moist, blue to yellowish gray, stiff, sandy CLAY, occasional roots; impervious fill
D2	10	88			1.7		D2: As above, slightly sandy, no roots, plastic, yellowish brown
				0.005			
D3	13	66	24.0		1.5		D3: As above, stratified, dark yellowish brown to dark bluish gray (organic grass), silty CLAY, occasional slightly sandy organic layer looks like old grass, sod or turf
U1 U2		68 72	24.2		2.5 1.25	CL	Two tubes 16", 12.5", Torvane 5.5 tsf on U2. (U1 dry density (PCF) = 91.9)
				0.13			
D4	14	50			2.1	CL	D4: As above, mostly yellowish brown, slightly sandy overall, driller mentioned it felt sandy above D4
				0.00008			
D5	19	0					D5: Hole caved, lost D5
				0.00007			
D6	21	61			1.1	CL	D6: As above, sandy, scattered fine rounded/subrounded gravel
				0.00007			
D7	21	72	18.9		2.6		D7: As above, slightly sandy, scattered gravel, organic debris in bluish zones
				0.5			
D8	24	88			2.3		D8: As above, very little organics
				1			47': Rock
							49': Clay
D9	20	72	22.3		2.0		D9: As above, sandy seam near bottom, a minimum 1" stoneline near top, several organic layers with grass
				1.5			
D10	50 - 2"	100					54.5' Gravelly, perm test 45-55 very fast
				1.5			D10: Moist, dark bluish gray, very dense, friable, slightly clayey SILT and GRAVEL, becomes dark bluish gray ROCK; decomposed to weathered TUFF
				0.064			Note: Began coring at 55'
				0.007			Completion: 17.5' of sand from bottom of the hole to 56' (1' above screen), 2.5' of screen, bentonite pellets from 56' to 43.4' depth (1' below upper screen), 5' screen; 5' sand from 43.4 to 36.4' depth (to 1' above upper screen), bentonite pellets then drill cuttings to top of hole. Stickup DH 105A 1.25' above ground surface, DH 105B 1.45' above ground surface.
				0.005			

what is this

CORE DESCRIPTION RECORD

WOMACK & ASSOCIATES, INC.
Engineers and Geoscientists

Page 2 of 3

Client: DNRC
Location:
Geologist: Womack

State: Montana
Sec.: T: R:
Driller:

Project: Bearpaw
County:
Elevation:
Core Size: NQ

Hole # 105
Date: 6-29-91

								ROCK DESCRIPTION						FRACTURE DESCRIPTION								
CORE RUN	BOX/SAMPLE #	% RECOVERY	FRAC. FREQ. (CODE)	STRENGTH (CODE)	RQD (%)	WEATHERING (CODE)		LITHOLOGY	INTERVAL	TYPE	COLOR	GRAIN SIZE	BEDDING (CODE)	INTERVAL	TYPE	DIP (DEGREES) DIRECTION	DIP (DEGREES)	SPACING (CODE)	OPENING (CODE)	SURFACE CONDITION	FILLING	COMMENTS
1	1	44	3	2	12	SL				Tuff	Dark Bluish Gray				JN		40	4"		RG	Chlorite washed out	Other random fractures very tight. Rock strong Mafic tuff
2	1	100	2	1	80	V SL				Tuff	Dark Bluish Gray				JN		10-80		v. nar	RG-WV	Calcium carbonate, gypsum	Blocked off 63.3
3	1	100	4	2	42	V SL									JN		1"-3"	1"-3"	v. nar to nar	RG-FL	Calcium carbonate	As above, tuff coarser gravel

WOMACK & ASSOCIATES, INC.
Engineers and Geoscientists

CORE DESCRIPTI[illegible] RECORD

Page 3 of 3

Client: DNRC
Location:
Geologist: Womack

State: Montana
Sec.: T: R:
Driller:

Project: Bearpaw
County:
Elevation:
Core Size: NQ

Hole # 105
Date: 6-29-91

								ROCK DESCRIPTION						FRACTURE DESCRIPTION								
CORE RUN	BOX/SAMPLE #	% RECOVERY	FRAC. FREQ. (CODE)	STRENGTH (CODE)	RQD (%)	WEATHERING (CODE)		LITHOLOGY	INTERVAL	TYPE	COLOR	GRAIN SIZE	BEDDING (CODE)	INTERVAL	TYPE	DIP (DEGREES) DIRECTION	DIP (DEGREES)	SPACING (CODE)	OPENING (CODE)	SURFACE CONDITION	FILLING	COMMENTS
3	2	100	4	2	43	V. SL				Tuff	Dark Bluish Gray	Var									As above, calcium carbonate	As above
4	2	100	1	1	100	F				Tuff	As above			Hairline to very narrow fractures - closed or filled, core solid and unbroken. Orientation variable.						RG		
5	2	100	1	1-2	100	F				Tuff	As above			Fracture as above, core does not break	JN	45		Only one	C-VN	SM	Some evidence slickensided - surface grooved or polished	

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Engineers and Geoscientists

TEST HOLE LOG

PAGE 1 OF 3

PROJECT: Bearpaw Dam

HOLE NO.: DH 106

DATE: 6-30-91

TEST HOLE LOCATION: 110' east of new bridge, north side of embankment between spill and building

ELEVATION G.S.: Approx. 3605

TOTAL DEPTH: 50.1'

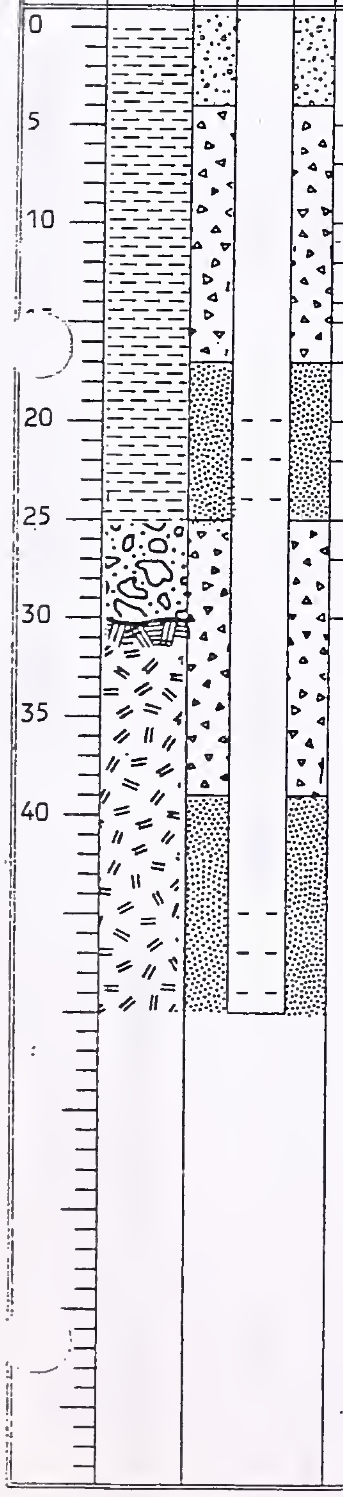
GROUNDWATER LEVEL: None

MEASURED FROM:

DRILL TYPE: CME55 Rotary

DRILLER: RBG-Hartley

LOGGED BY: Womack



SAMPLE	SPT (N) BLOWS/FT	RECOVERY (%)	MOISTURE CONTENT (%)	HYDRAULIC CONDUCTIVITY (FT/DAY)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION AND REMARKS
D1	12	0					
U1		100			2.9		U1: Gravelly CLAY, torvane read average of 18.2 TSF
D2	13	72		0.017	3.0		D2: Moist, yellowish brown, stiff, slightly sandy CLAY; impervious fill
U2		50	22.8		2.9	CH	U2: As above, grayish brown, torvane average of 15 TSF (dry density of sample U2 is 97.7 pcf)
				0.0011			
D3	17	72			3.1		D3: As above, stratified, yellowish brown to grayish brown, occasional bluish gray layers with roots, some layers sandy, occasional subrounded to subangular gravel
				0.0022			
D4	54	44					D4: As above to 26.0', wet, then reddish brown, dense, clayey SAND, GRAVEL
				0.0018			D4 sample: Clay only
D5	5 - 2"	100					D5: Reddish gravel with a little clay; probably weathered rock (sample not retained)
							Began coring at 30'
				17.4			30-31' Highly weathered TUFF 31-50.1' Slightly weathered TUFF
							Completion: 5' screen at 45-50' and 20-25', 10-20 sand from 50-39' depth, 3/8" enviroplug pellets from 39-25', 10-20 sand 25-17', 3/8" pellets to 4', stickup 1.3'
				0.1			

WOMACK & ASSOCIATES, INC.
Engineers and Geoscientists

CORE DESCRIPTION RECORD

Page 2 of 3

Client: DNRC
Location:
Geologist: Womack

State: Montana
Sec.: T: R:
Driller:

Project: Bearpaw
County:
Elevation:
Core Size: NQ

Hole # 106
Date: 6-30-91

								ROCK DESCRIPTION						FRACTURE DESCRIPTION								
CORE RUN	BOX/SAMPLE #	% RECOVERY	FRAC. FREQ. (CODE)	STRENGTH (CODE)	RQD (%)	WEATHERING (CODE)		LITHOLOGY	INTERVAL	TYPE	COLOR	GRAIN SIZE	BEDDING (CODE)	INTERVAL	TYPE	DIP (DEGREES) DIRECTION	DIP (DEGREES)	SPACING (CODE)	OPENING (CODE)	SURFACE CONDITION	FILLING	COMMENTS
			5	5	0	Highly				Tuff	Bluish gray stained orange				Very highly fractured							
1	1	78	1	1	100	SL					Dark bluish gray				JN		VAR	1	C-VN	RG-F	Chlorite?	Blocked off
2	1	100	1	1	100	SL				Tuff	Dark bluish gray				Rock randomly fractured as 105, but closed or filled - does not break along defects.							Rock stained throughout 37.1-37.4
			4	2	0		Mod		37.1 37.6		Dark reddish brown				Stained area probably adjacent to major fractures							
3	1	100	1	2							Dark bluish gray											Total water loss Green chlorite staining

WOMACK & ASSOCIATES, INC.
Engineers and Geoscientists

CORE DESCRIP N RECORD

Page 3 of 3

Client: DNRC
Location:
Geologist: Womack

State: Montana
Sec.: T: R:
Driller:

Project: Bearpaw
County:
Elevation:
Core Size:

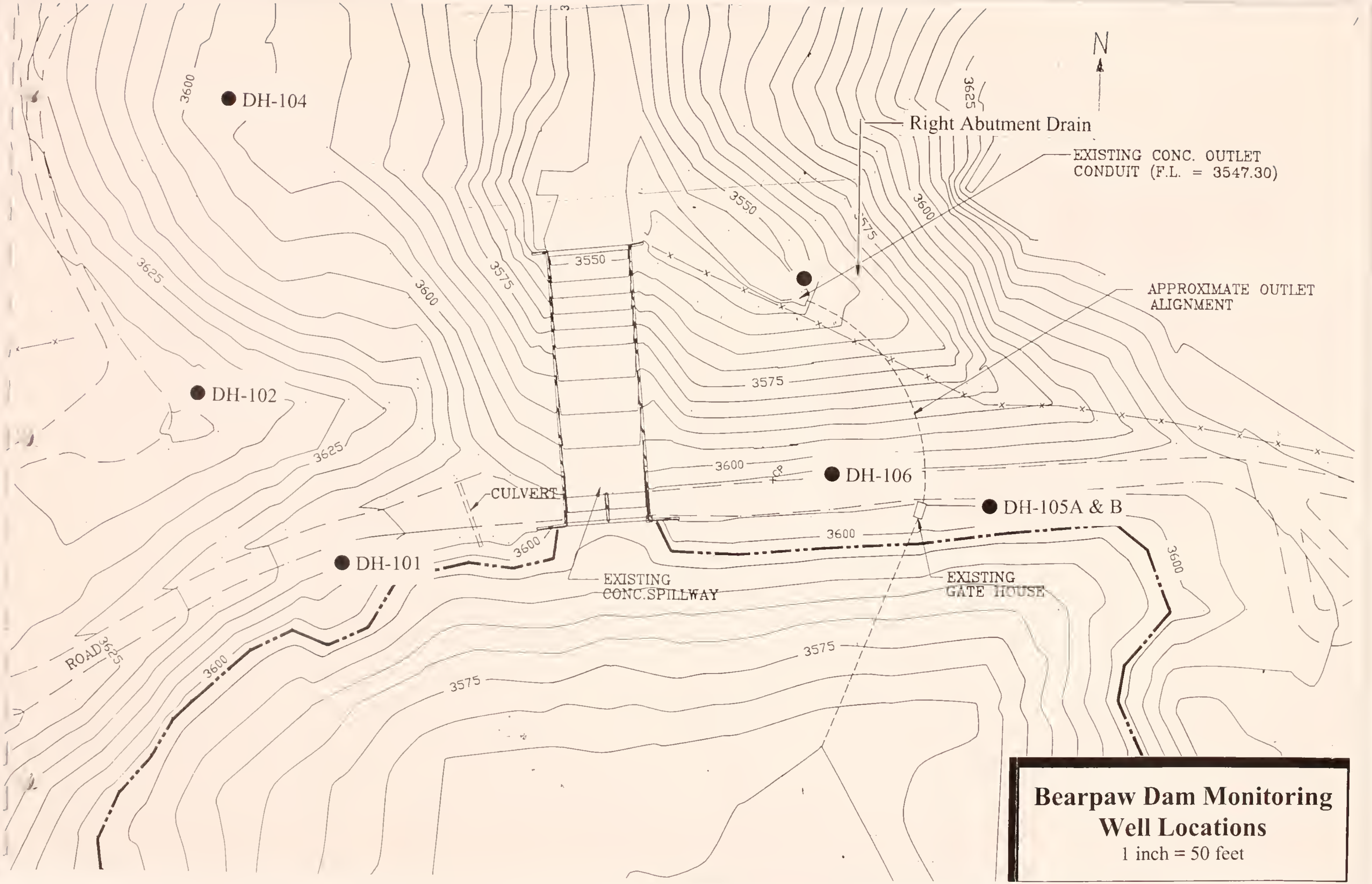
Hole # 106
Date: 6-30-91

									ROCK DESCRIPTION						FRACTURE DESCRIPTION								
	CORE RUN	BOX/SAMPLE #	% RECOVERY	FRAC. FREQ. (CODE)	STRENGTH (CODE)	RQD (%)	WEATHERING (CODE)		LITHOLOGY	INTERVAL	TYPE	COLOR	GRAIN SIZE	BEDDING (CODE)	INTERVAL	TYPE	DIP (DEGREES) DIRECTION	DIP (DEGREES)	SPACING (CODE)	OPENING (CODE)	SURFACE CONDITION	FILLING	COMMENTS
0																							
1															41.0	JN		0	4'	W	R	SN-DK RD BN - SN zone 0.1''wide	
2	3	2	100	1	2	100	SL				Tuff	Dark bluish gray			Other defects random core does not break. Fractures at 37.4 and 41.0 are major breaks, take a lot of water.								
6	4	2	100	1	2	100					Tuff	As above											
7															Other joints occasionally break with slight knock - rough, clean, closed - random orientation								
9					2	0		48.5 48.9				Yellowish brown			48.5-49	JN		0-10	2"	N	R	Calcium carbonate 48.4-48.85	- rock stained
					2	100					Tuff	Dark bluish gray											
10																							

APPENDIX E

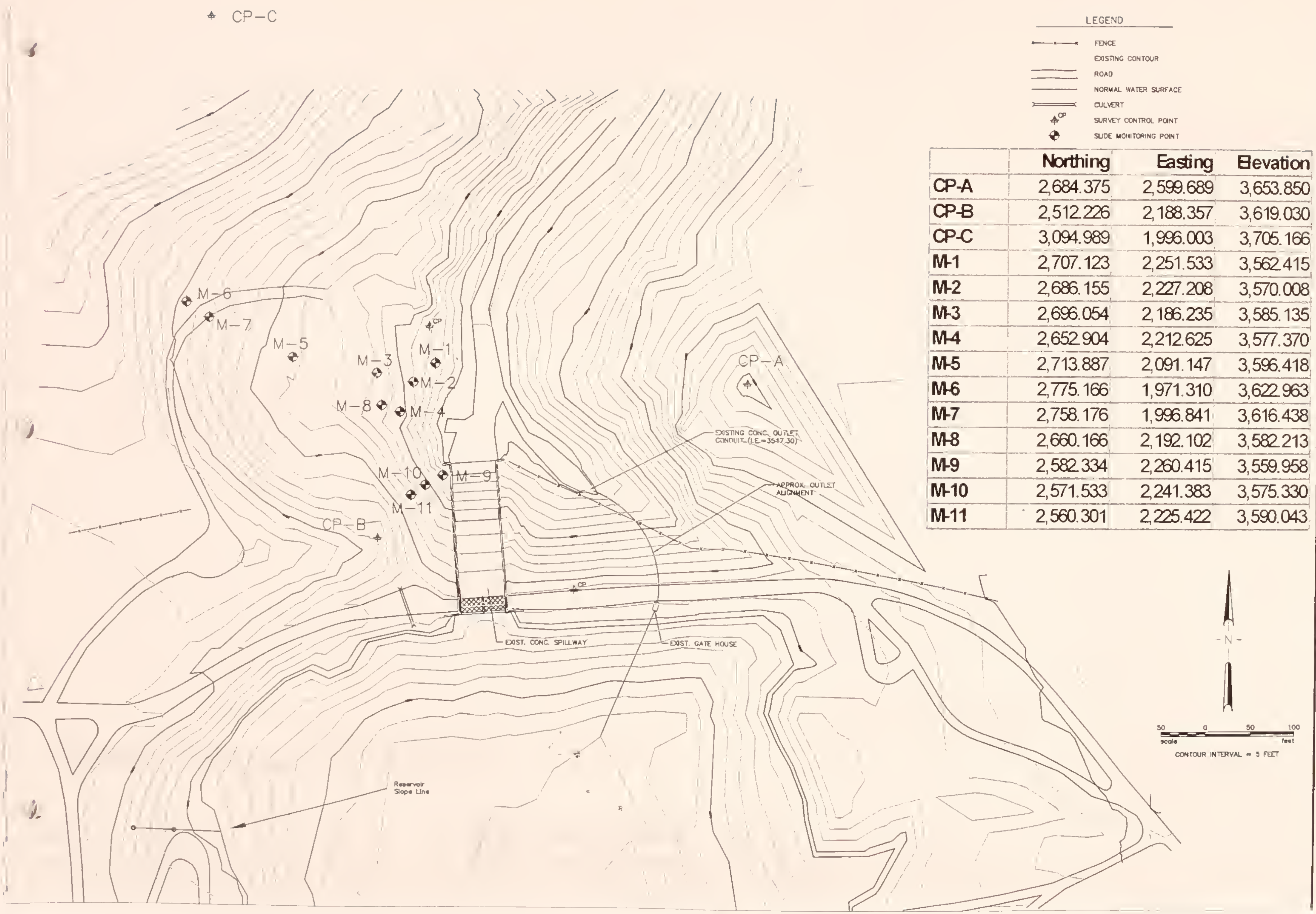
PROJECT DRAWINGS

(NOTE: These reduced project drawings are design drawings and not "As Builts". These drawing should be used for reference only. The SWPB has the full size project drawings.)



Bearpaw Dam Monitoring Well Locations

1 inch = 50 feet



	Northing	Easting	Elevation
CP-A	2,684.375	2,599.689	3,653.850
CP-B	2,512.226	2,188.357	3,619.030
CP-C	3,094.989	1,996.003	3,705.166
M-1	2,707.123	2,251.533	3,562.415
M-2	2,686.155	2,227.208	3,570.008
M-3	2,696.054	2,186.235	3,585.135
M-4	2,652.904	2,212.625	3,577.370
M-5	2,713.887	2,091.147	3,596.418
M-6	2,775.166	1,971.310	3,622.963
M-7	2,758.176	1,996.841	3,616.438
M-8	2,660.166	2,192.102	3,582.213
M-9	2,582.334	2,260.415	3,559.958
M-10	2,571.533	2,241.383	3,575.330
M-11	2,560.301	2,225.422	3,590.043

Base map developed by TD&H and MSE-HKM
Slide monitoring data added by DNRC

• BPBASE2.DWG • Date Nov. 1999

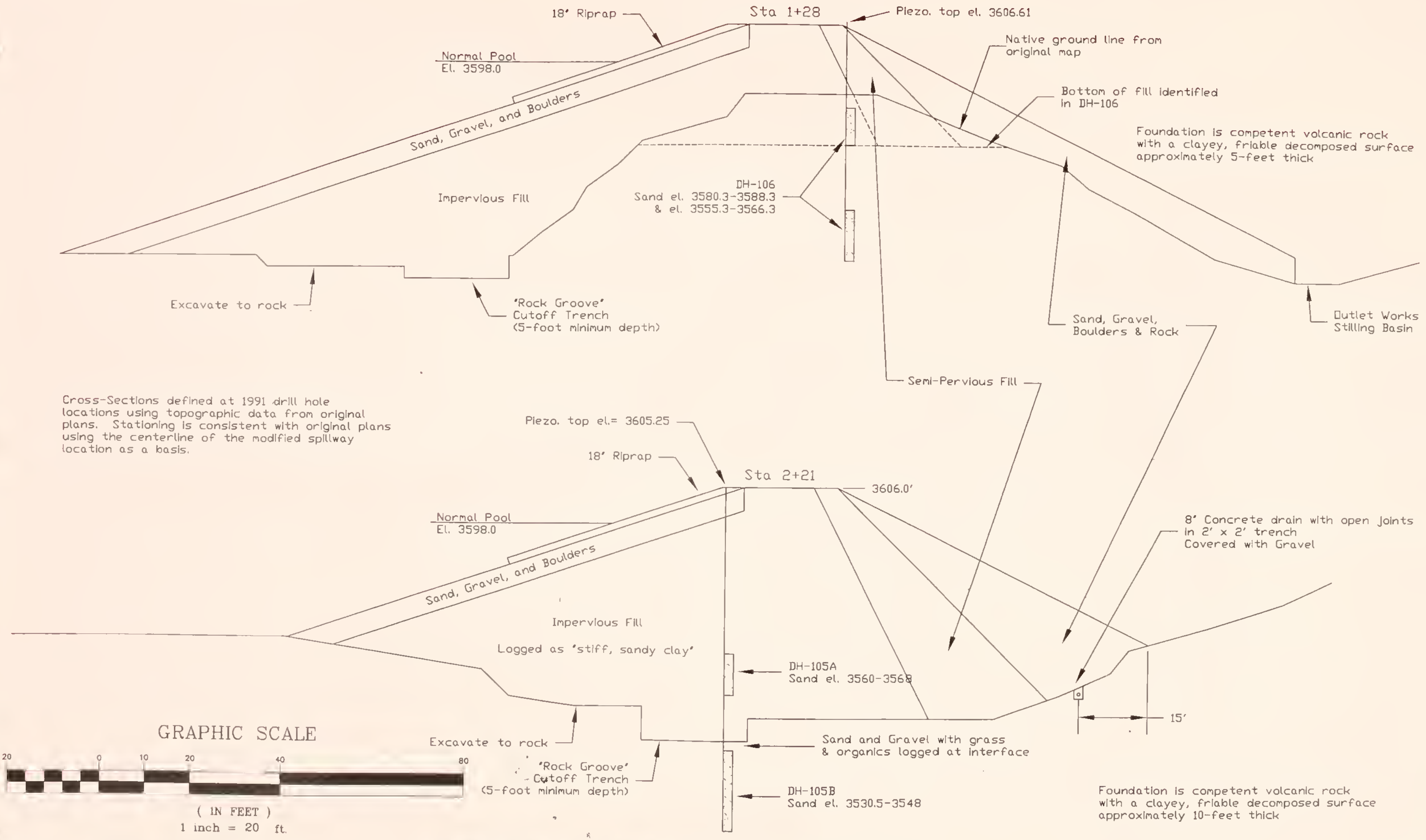
BEARPAW LAKE DAM
HILL COUNTY, MONTANA

Monitoring Pin Locations

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

Revised by	Date
Robert Kingery	5/19/00

Sheet No.
1
of 1


18' Riprap
Sta 1+28
Piezo. top el. 3606.61
Normal Pool
El. 3598.0
Native ground line from original map
Bottom of fill identified in DH-106
Sand, Gravel, and Boulders
Foundation is competent volcanic rock with a clayey, friable decomposed surface approximately 5-feet thick
Impervious Fill
DH-106
Sand el. 3580.3-3588.3
& el. 3555.3-3566.3
Excavate to rock
'Rock Groove'
Cutoff Trench
(5-foot minimum depth)
Sand, Gravel,
Boulders & Rock
Outlet Works
Stilling Basin
Semi-Pervious Fill
Cross-Sections defined at 1991 drill hole locations using topographic data from original plans. Stationing is consistent with original plans using the centerline of the modified spillway location as a basis.
Piezo. top el.= 3605.25
18' Riprap
Sta 2+21
3606.0'
Normal Pool
El. 3598.0
8' Concrete drain with open joints
in 2' x 2' trench
Covered with Gravel
Sand, Gravel, and Boulders
Impervious Fill
Logged as 'stiff, sandy clay'
DH-105A
Sand el. 3560-3568
15'
GRAPHIC SCALE
20
0
10
20
40
80
(IN FEET)
1 inch = 20 ft.
Excavate to rock
Sand and Gravel with grass
& organics logged at interface
'Rock Groove'
Cutoff Trench
(5-foot minimum depth)
DH-105B
Sand el. 3530.5-3548
Foundation is competent volcanic rock with a clayey, friable decomposed surface approximately 10-feet thick

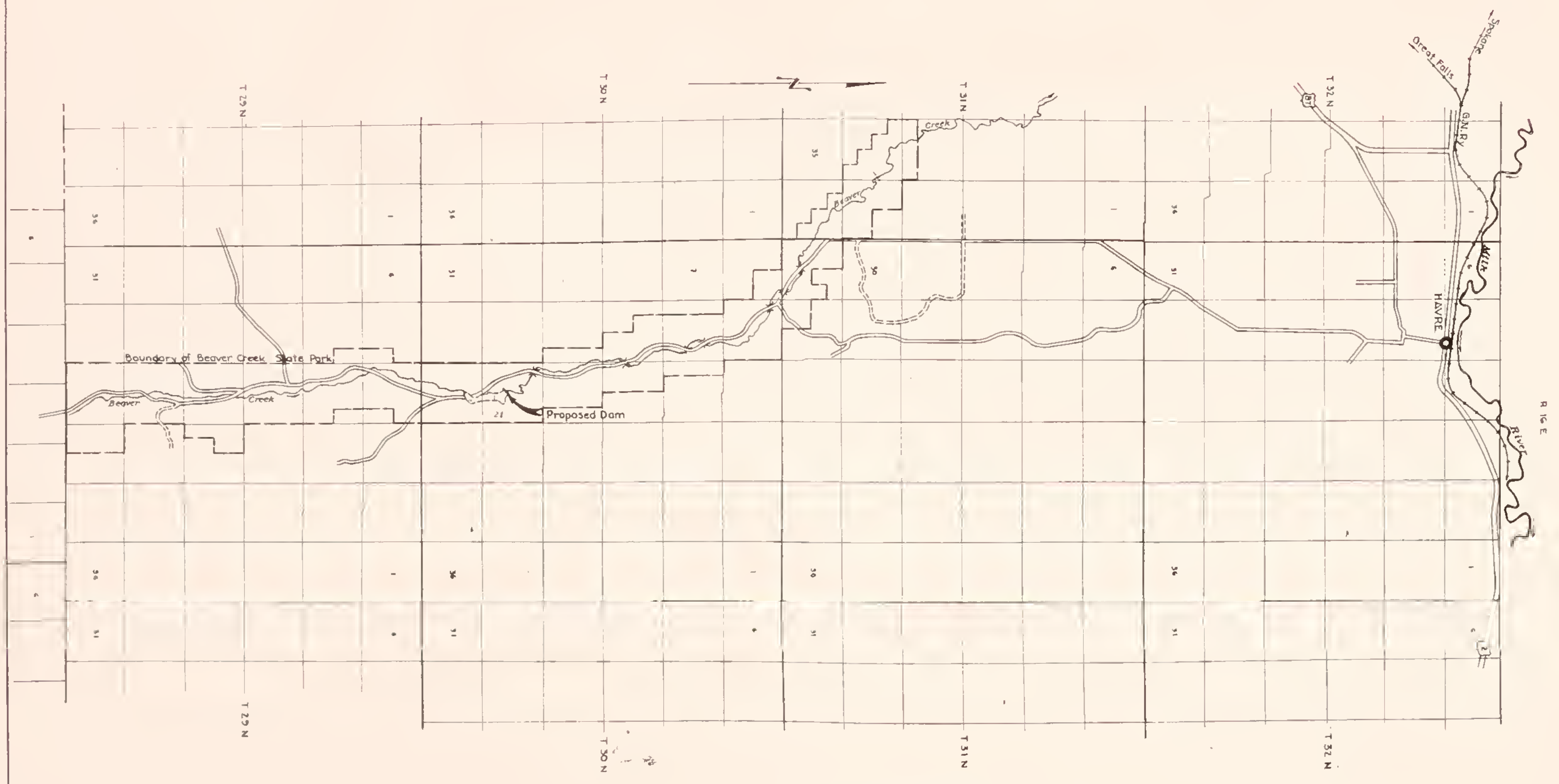
Robert Kingery DRAWN BY:	5/25/2000 DATE:	REVISED BY:	DATE:	APPROVED BY:	DATE:
CHECKED BY:	DATE:	APPROVED BY	DATE:	APPROVED BY	DATE:

Montana Fish, Wildlife & Parks

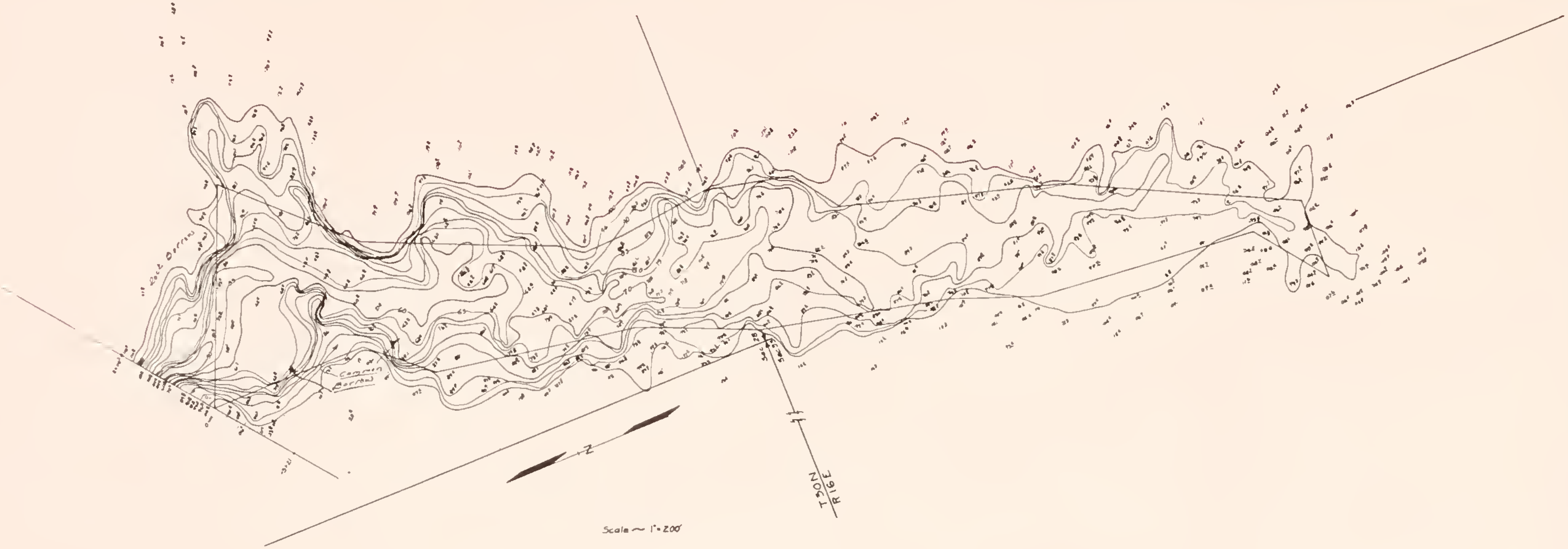
Bearpaw Dam
Embankment Cross-Sections

SHEET: 1 of 1

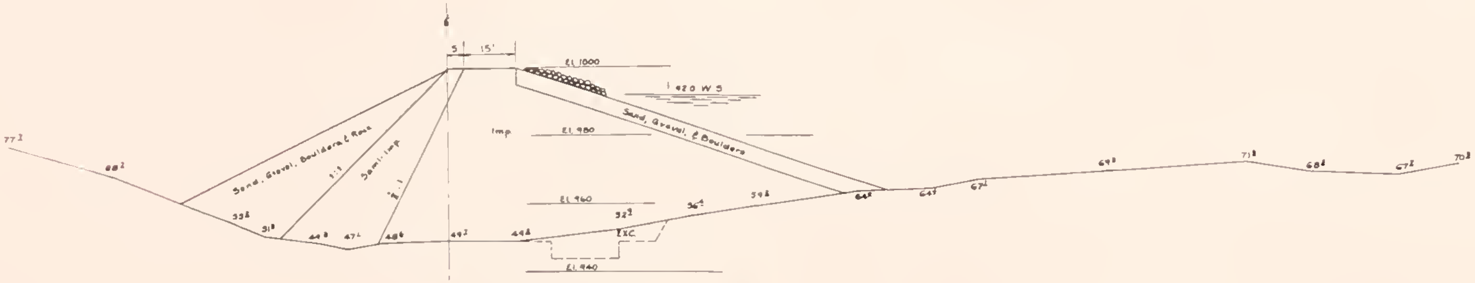
STATE FISH & GAME COMMISSION
BEAVER CREEK PROJECT
HILL COUNTY



NOT TO SCALE



Scale ~ 1"=200'



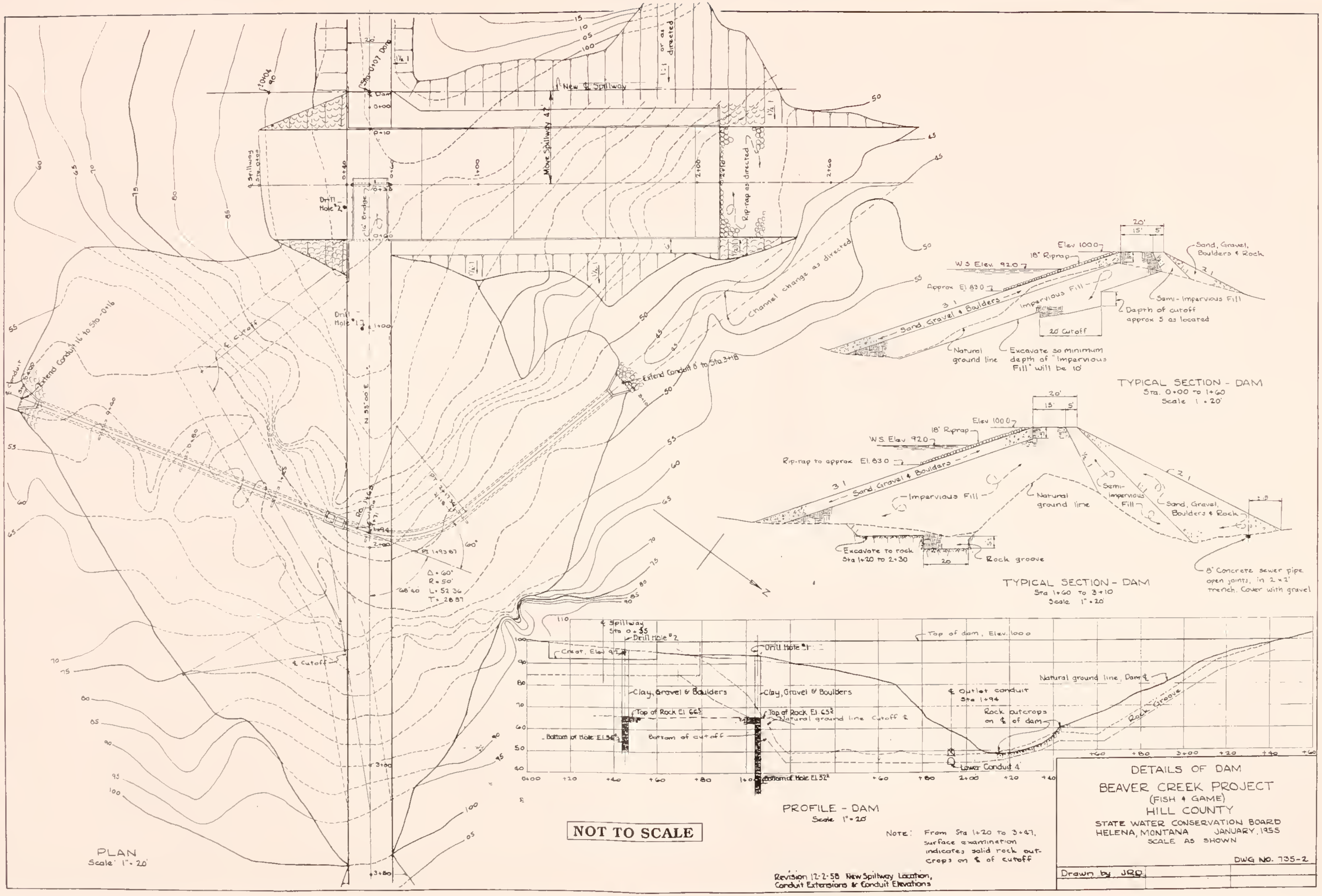
Sta. 2+07
Scale ~ 1"=20'

NOT TO SCALE

RESERVOIR & DAM
BEAVER CREEK PROJECT (F&G)
HILL COUNTY

STATE WATER CONSERVATION BOARD
HELENA, MONTANA SEPT. 1954
SCALE ~ As Shown DWG. NO. 735-1

5 735 1



NOT TO SCALE

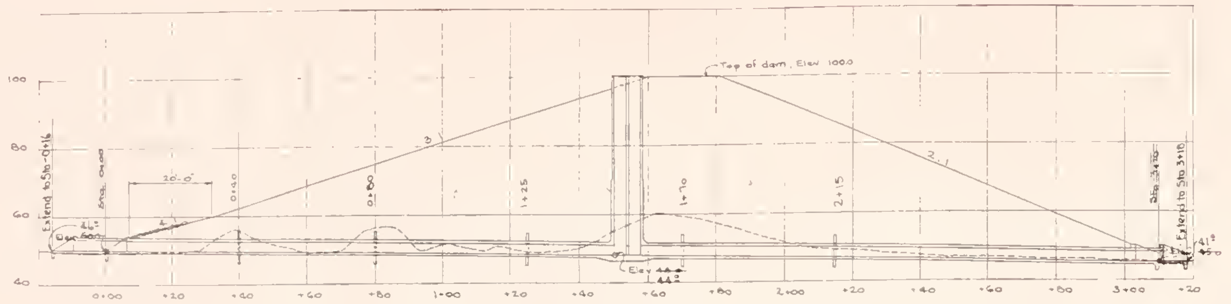
Note: From Sta 1+20 to 3+47, surface examination indicates solid rock outcrops on ℄ of cutoff

Revision 12-2-58 New Spillway Location, Conduit Extensions & Conduit Elevations

DETAILS OF DAM
BEAVER CREEK PROJECT
(FISH & GAME)
HILL COUNTY
STATE WATER CONSERVATION BOARD
HELENA, MONTANA JANUARY, 1955
SCALE AS SHOWN

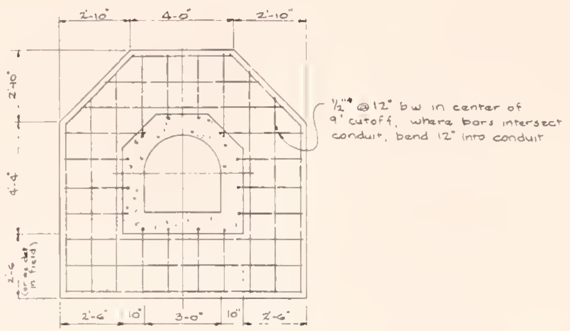
DWG NO. 735-2

Drawn by JRD

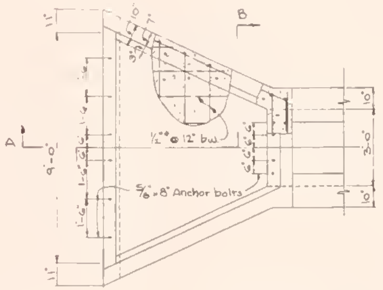


PROFILE OF CONDUIT
Scale 1" = 20'

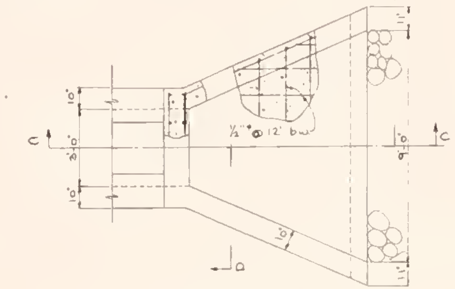
NOTE For "PLAN OF CONDUIT" see DWG NO 735-1


2'-10"
4'-0"
2'-10"
2'-10"
4'-4"
2'-6"
2'-6"
10"
3'-0"
10"
2'-6"
½"⌀ @ 12" bw in center of 9" cutoff, where bars intersect conduit, bend 12" into conduit

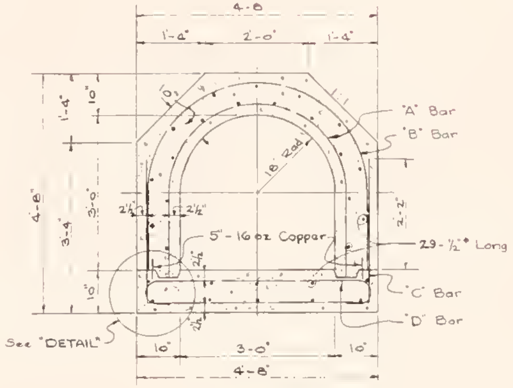
CONDUIT CUTOFF
Scale ⅜" = 1'-0"
Req'd - 5



PLAN OF INLET
Scale: ⅜" = 1'-0"



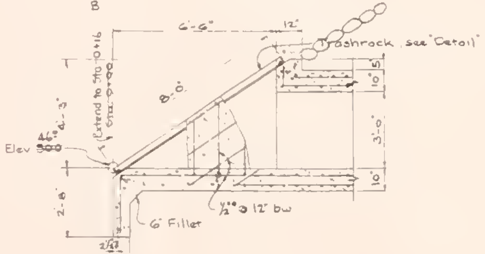
PLAN OF OUTLET
Scale ⅜" = 1'-0"



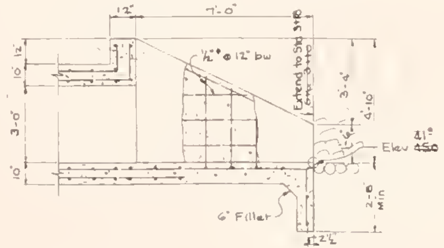
OUTLET CONDUIT
Scale ¾" = 1'-0"

SCHEDULE OF CONDUIT REINFORCEMENT

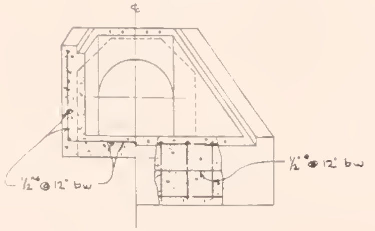
Station	Station	"A" Bars	"B" & "C" Bars	"D" Bars
-0+09.5 ~~0+06.5~~	0+70	¾"⌀ @ 12"	¾"⌀ @ 6"	¾"⌀ @ 12"
0+70	2+55	¾"⌀ @ 9"	¾"⌀ @ 4½"	¾"⌀ @ 9"
2+55	~~3+02~~ 3+10.5	½"⌀ @ 10½"	½"⌀ @ 10½"	½"⌀ @ 10½"



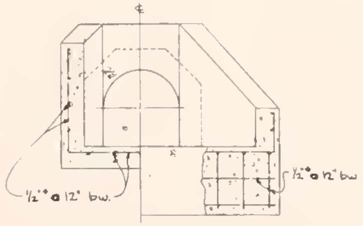
SECTION A-A



SECTION C-C



SECTION B-B



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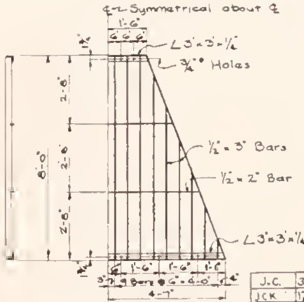
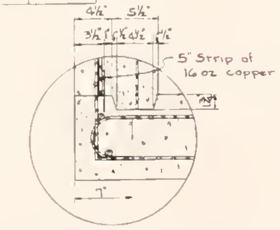


TRASHRACK DETAILS
Req'd: 1-Right & 1 Left



CONSTRUCTION JOINT DETAIL
Scale: 1½" = 1'-0"

NOTES
Chamfer exposed edges of concrete
Lap all reinforcing bar splices 40 diameters
Hooks shall have a radius of 3 bar diameters and an extension of 4 bar diameters
Minimum cover of concrete over reinforcing - 2"

NOT TO SCALE

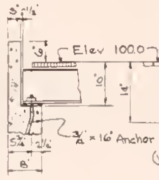
REVISIONS

J.C.	3 July 58	Revised Longitudinal Conduit Steel
JCK	12-4-58	Extended Conduit Inlet & Outlet, Changed Conduit Elev's

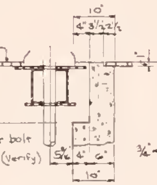
OUTLET CONDUIT
BEAVER CREEK PROJECT
(FISH & GAME)
HILL COUNTY
STATE WATER CONSERVATION BOARD
HELENA, MONTANA FEBRUARY, 1955
SCALE AS SHOWN

DWG NO 735-3

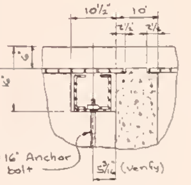
Drawn by JRD



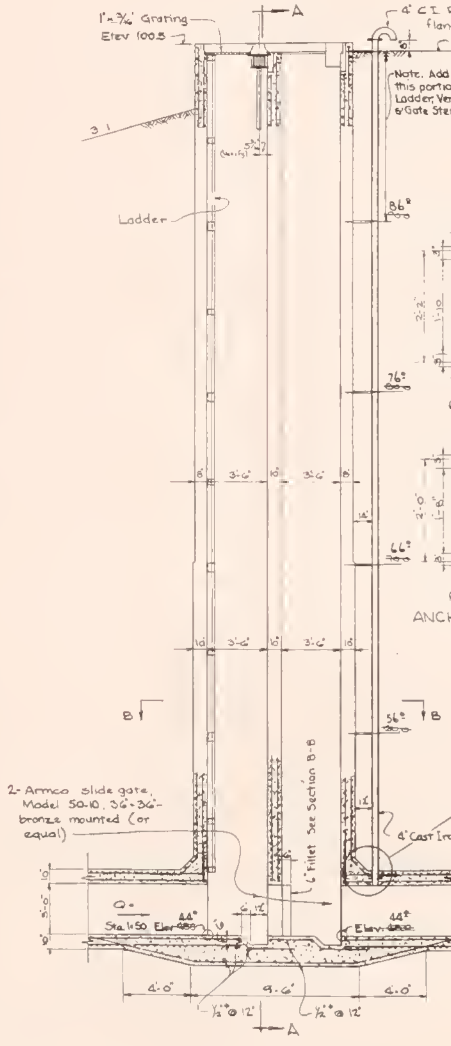
SECTION D-D



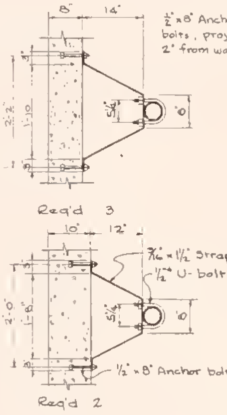
SECTION E-E



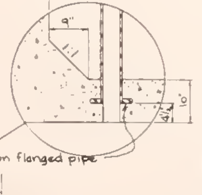
SECTION F-F

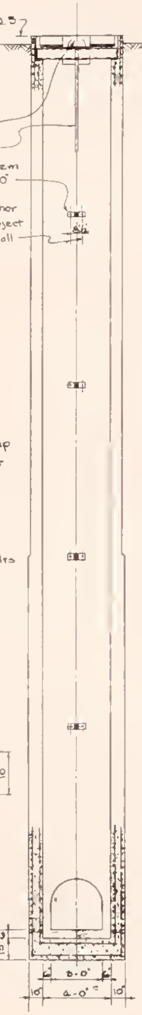

1" × 3/16" Grating
Elev 100.5
A
4" C I Return bend, flanged on one end
Top of dam, Elev 100.0
Note. Add 4 to this portion for Ladder Vent Pipe & Gate Stems
Armco open gear pedestal lift - CP.12 12.1 with 3" stem (or equal)
3" Steel stem
Fully adjustable stem guides, @ approx 10'-0"
Ladder
3:1
86°
76°
66°
56°
B
2 - Armco slide gate, Model 50-10, 36" × 36" bronze mounted (or equal)
6" Fillet See Section B-B
4" Cast Iron flanged pipe
Sta 1+50 Elev 44°
Elev 44°
Q
4'-0"
9'-6"
4'-0"
½" @ 12"
3'-6"
10"
3'-6"

CONTROL TOWER SECTION
Scale ¼" - 1'-0"

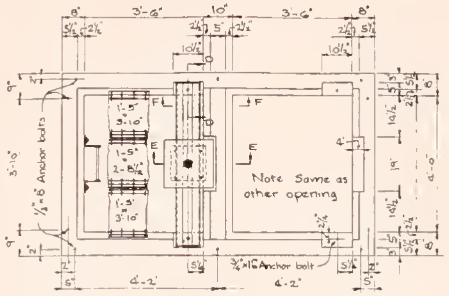


ANCHORS FOR VENT PIPE
Scale ¾" - 1'-0"

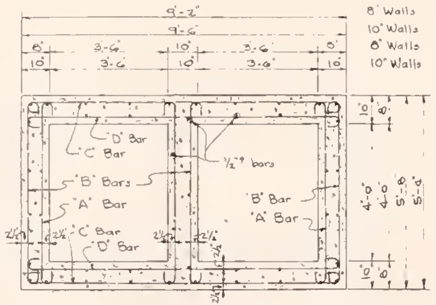




SECTION A-A



CONTROL HOUSE FOUNDATION
Scale ½" = 1'-0"
Req'd: 4 - 1'-5" × 3'-10" and 2 - 1'-5" × 2'-8½" 1" × 3/16" Grating

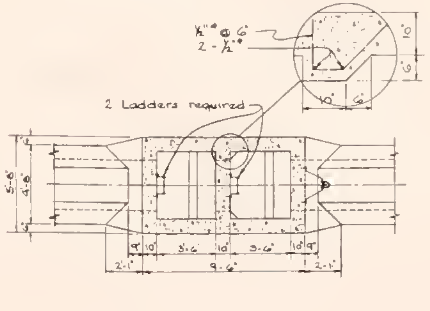


TYPICAL TOWER SECTION
Scale ½" - 1'-0"

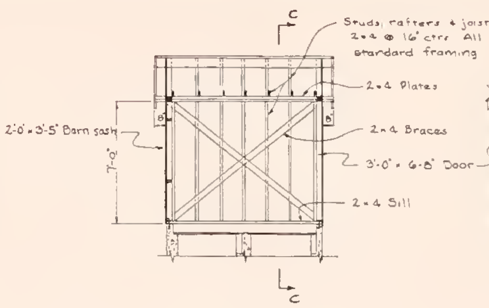
SCHEDULE OF REINFORCING STEEL

Elevation	Bars 'A'	Bars 'B' & 'C'	Bars 'D'	Vert. Bars
81 100 to ~~85~~	½" @ 12"	½" @ 12"	½" @ 12"	45 - ½"
8" Wall 81 to 66 ~~85 to 70~~	5/8" @ 12"	½" @ 6"	3/8" @ 12"	"
66 to 56 ~~70 to 60~~	5/8" @ 11"	½" @ 5½"	½" @ 11"	"
10 Wall 56 to 44 ~~60 to 48~~	5/8" @ 9"	½" @ 4½"	5/8" @ 9"	"

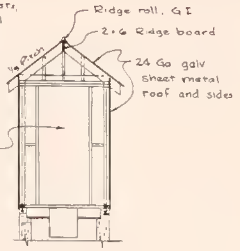
All horizontal bars hooked at both ends
Vertical bars spaced as shown on typical tower section.



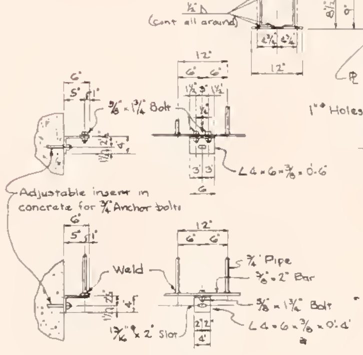
SECTION B-B



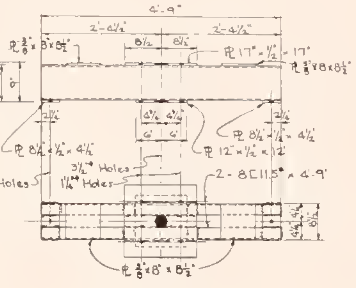
CONTROL HOUSE SECTION
Scale ¼" = 1'-0"



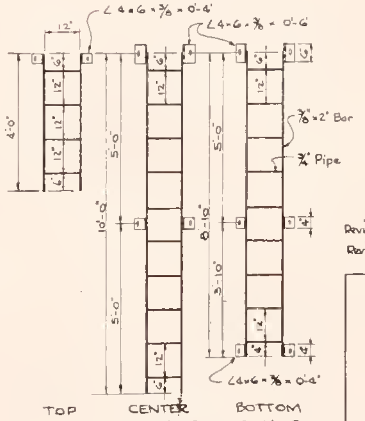
SECTION C-C



LADDER DETAILS
Scale ¾" = 1'-0"



PEDESTAL LIFT SUPPORT
Req'd. - 2
Scale ¾" = 1'-0"



LADDER DETAILS
Scale ½" = 1'-0"

NOT TO SCALE

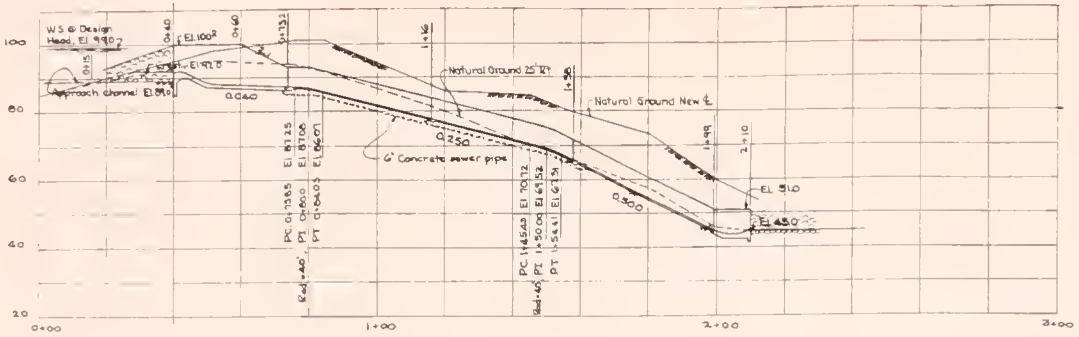
NOTES
Chamfer exposed edges of concrete 1".
Lap all reinforcing bar splices 40 diameters
Hooks shall have a radius of 3 bar diameters and an extension of 4 bar diameters
Minimum cover of concrete over reinforcing - 2"

Revision 1-12-59 Pedestal Lift Support - added 2 - ℞ ⅜ × 8" × 8½"
Revision 12-1-58 Tower Elevations, Ladder Details, some bolt sizes and Schedule of Reinforcing Steel

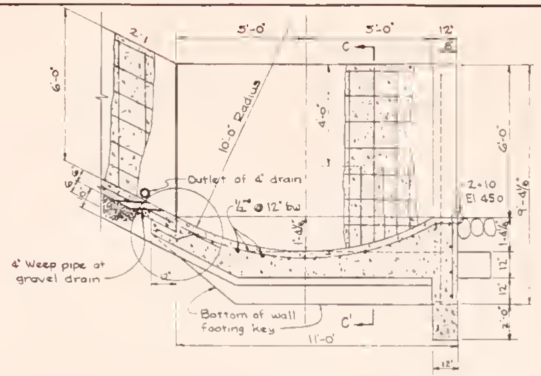
CONTROL TOWER DETAILS
BEAVER CREEK PROJECT
(FISH & GAME)
HILL COUNTY
STATE WATER CONSERVATION BOARD
HELENA, MONTANA FEBRUARY, 1955
SCALE AS SHOWN

DWG NO 735-4

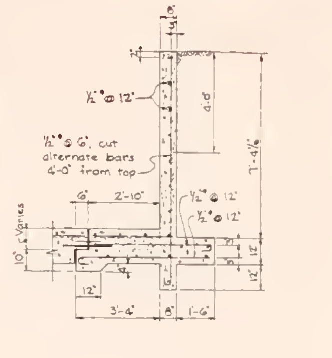
Drawn by JRO



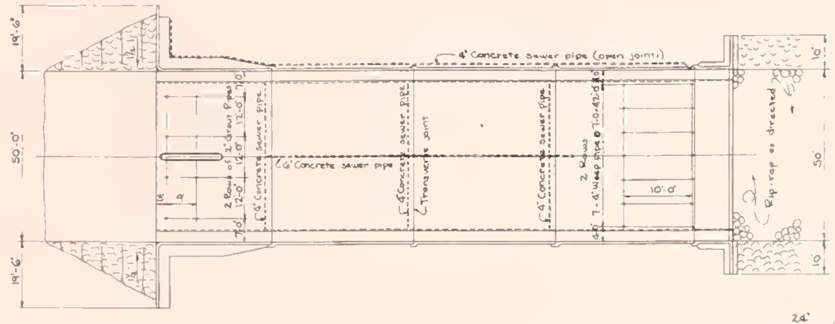
PROFILE - SPILLWAY
Scale 1" = 20'



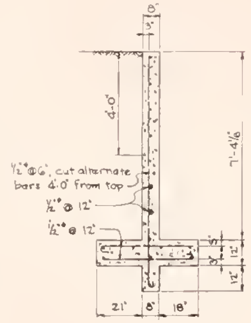
SECTION A-A



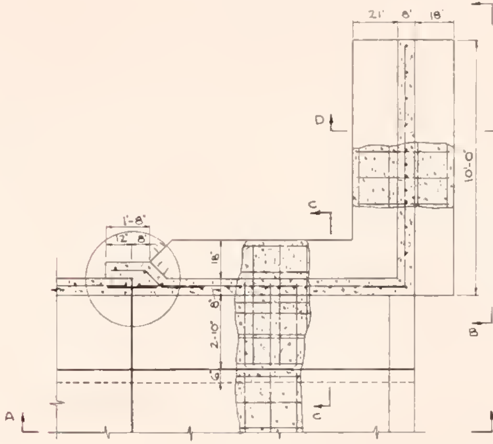
SECTION C-C



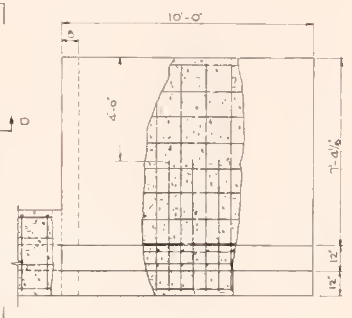
PLAN - SPILLWAY
Scale 1" = 20'



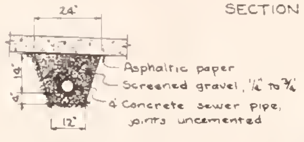
SECTION D-D



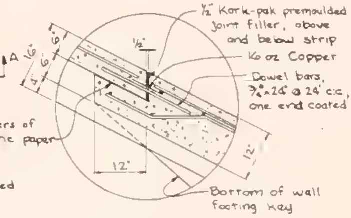
LOWER END OF SPILLWAY
Scale ⅜" = 1'-0"



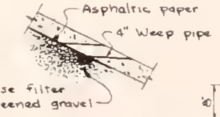
SECTION B-B


24"
Asphaltic paper
Screened gravel, ¼" to ¾"
4" Concrete sewer pipe, joints uncemented
12"

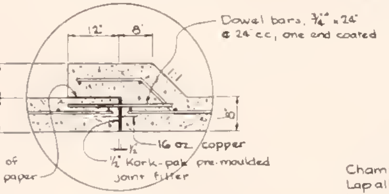
4" DRAIN DETAIL
Scale ½" = 1'-0"


½" Kork-pak premoulded joint filler, above and below strip
16 oz Copper
Dowel bars, ¾" ● × 24" @ 24" c/c, one end coated
2 Layers of asphaltic paper
12"
Bottom of wall footing key

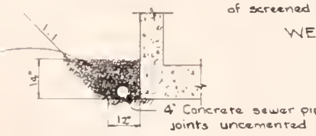
FLOOR SLAB JOINT DETAIL
Scale ¾" = 1'-0"



WEEP PIPE DETAIL
Scale ½" = 1'-0"


Dowel bars, ¾" × 24" @ 24" cc, one end coated
12"
8"
16 oz copper
½" Kork-pak pre-moulded joint filter
2 Layers of asphaltic paper

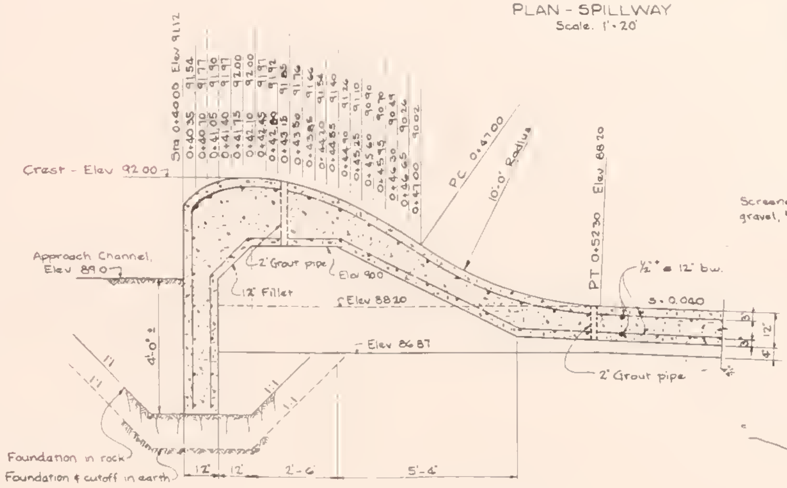
WALL JOINT DETAIL
Scale ¾" = 1'-0"


Screened gravel, ¼" to ¾"
4" Concrete sewer pipe, joints uncemented
12"

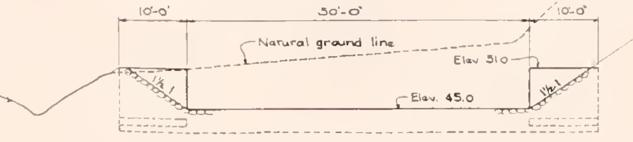
4" WALL DRAIN DETAIL
Scale ½" = 1'-0"

NOT TO SCALE

NOTES
Chamfer exposed edges of concrete 1"
Lap all reinforcing bar splices 40 diameters
Hooks shall have a radius of 3 bar diameters and an extension of 4 bar diameters.
Minimum cover of concrete over reinforcing - 2"



SPILLWAY CREST DETAIL
Scale ½" = 1'-0"



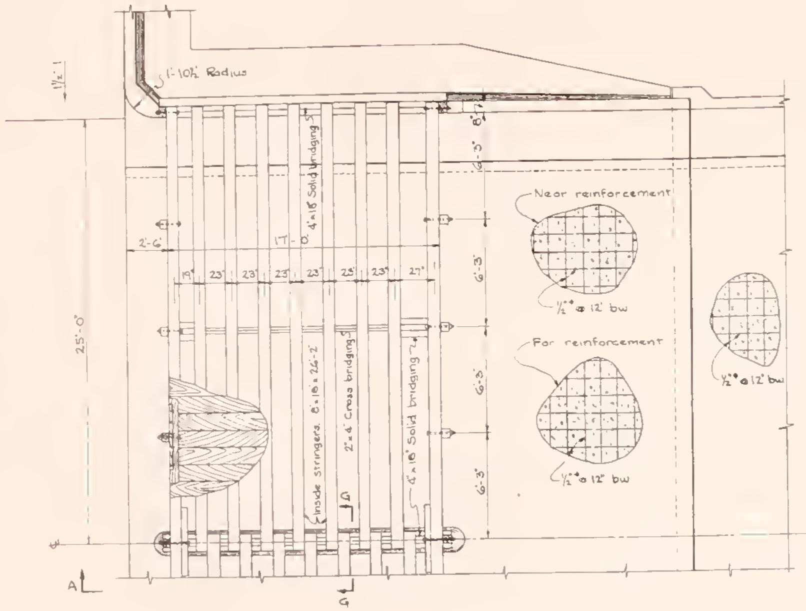
DOWNSTREAM ELEVATION OF SPILLWAY
Scale 1" = 10'

Revision 11-14-58 changed Profile of Spw to fit New Topog by Maynard of 10-27-58

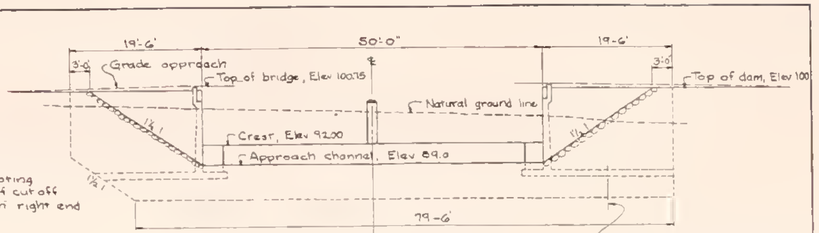
SPILLWAY
PLAN & PROFILE - CREST AND OUTLET DETAILS
BEAVER CREEK PROJECT
(FISH & GAME)
HILL COUNTY
STATE WATER CONSERVATION BOARD
HELENA, MONTANA FEBRUARY, 1955
SCALE AS SHOWN

DWG NO 735-8

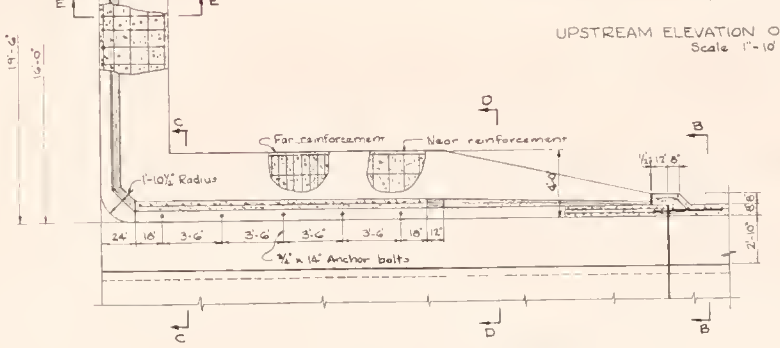
Drawn by JRD	Revised 11-14-58 JCK.	



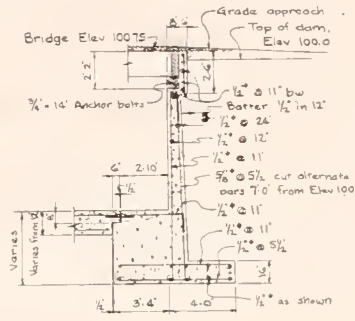
PLAN OF SPILLWAY CREST & BRIDGE
Scale ⅛" = 1'-0"


19'-6"
50'-0"
19'-6"
3'-0"
Grade approach
Top of bridge, Elev 100.75
Top of dam, Elev 100
Natural ground line
Crest, Elev 92.00
Approach channel, Elev 89.0
1½:1
79'-6"
℄ Dam cutoff trench, bottom grade, if in rock = Elev 85.0, if in earth = Elev 84.0

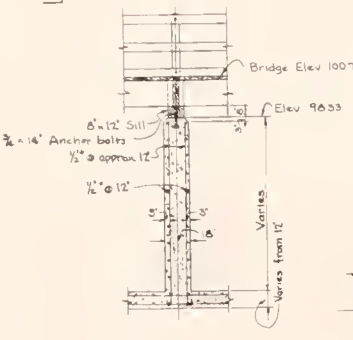
UPSTREAM ELEVATION OF SPILLWAY
Scale 1" = 10'



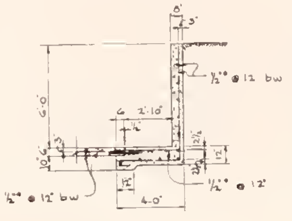
PARTIAL PLAN UPPER END OF SPILLWAY
Scale ⅛" = 1'-0"



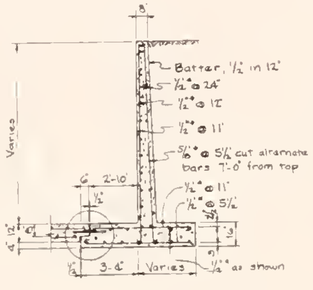
SECTION C-C



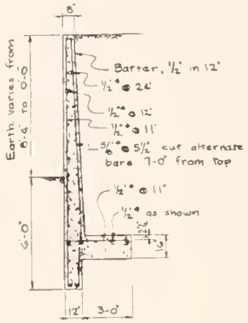
SECTION G-G



SECTION B-B



SECTION D-D

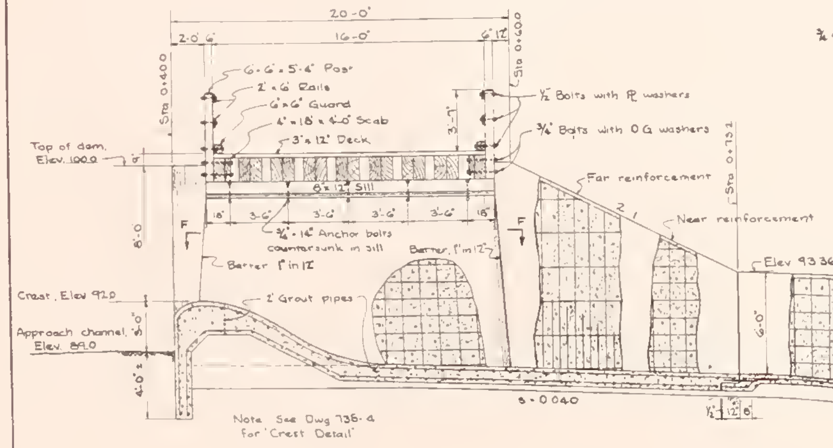


SECTION E-E

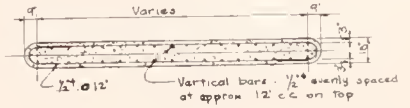
NOT TO SCALE

NOTES

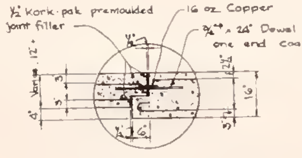
Chamfer exposed edges of concrete 1"
Lap all reinforcing bar splices 40 diameters
Hooks shall have a radius of 3 bar diameters
and an extension of 4 bar diameters
Minimum cover of concrete over reinforcing - 2"



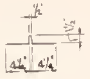
SECTION A-A
Scale ⅛" = 1'-0"



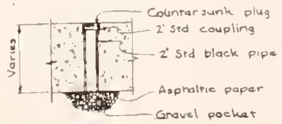
SECTION F-F


½" Kork-pak premoulded joint filler
16 oz. Copper
¾"⌀ x 24" Dowel @ 24" c.c. one end coated
Varies 12"
16"

LONGITUDINAL FLOOR JOINT
Scale ½" = 1'-0"



16 oz. COPPER SEAL
Scale 1" = 1'-0"



GROUT PIPE DETAIL
Scale 1" = 1'-0"

SPILLWAY
INLET AND BRIDGE
BEAVER CREEK PROJECT
(FISH & GAME)
HILL COUNTY
STATE WATER CONSERVATION BOARD
HELENA, MONTANA FEBRUARY, 1935
SCALE AS SHOWN

DWG. No. 735-6

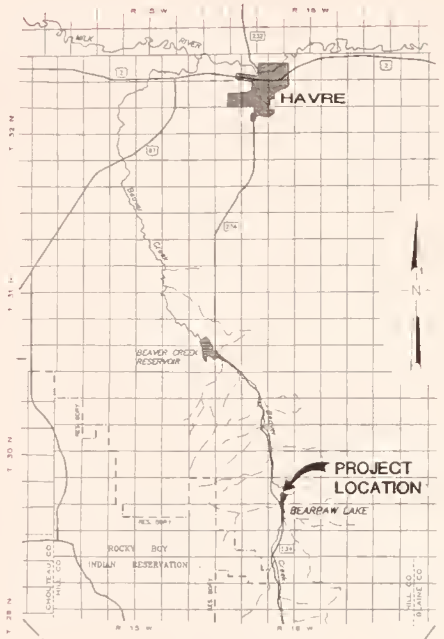
Drawn by JRD

REBID
CONSTRUCTION DRAWINGS

for the

BEARPAW LAKE DAM REHABILITATION PROJECT

HILL COUNTY, MONTANA



LOCATION MAP

SHEET INDEX

G1	COVER SHEET
G2	GENERAL SITE PLAN
G3	DAM IMPROVEMENT PLAN, SECTIONS AND DETAILS
G4	ROAD RELOCATION PLAN, PROFILE AND SECTIONS
S1	SPILLWAY PLAN AND PROFILE
S2	SPILLWAY DETAILS
S3	SPILLWAY BRIDGE

Prepared for :

Montana Fish, Wildlife & Parks

and

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
Water Resources Division, Water Projects Bureau
1520 East 6th
Helena, Montana 59620–2301
(406)444–6646

Glen McDonald

Glen McDonald, P.E. 4391 E
Chief, Water Projects Bureau
Montana DNRC

Prepared by :

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HKM Associates

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Jason H. Thom

Jason Thom, P.E. 6396E
Project Manager
HKM Associates

Proj. No. 8M087.144

January 1995

Sheet No
G1
of 4

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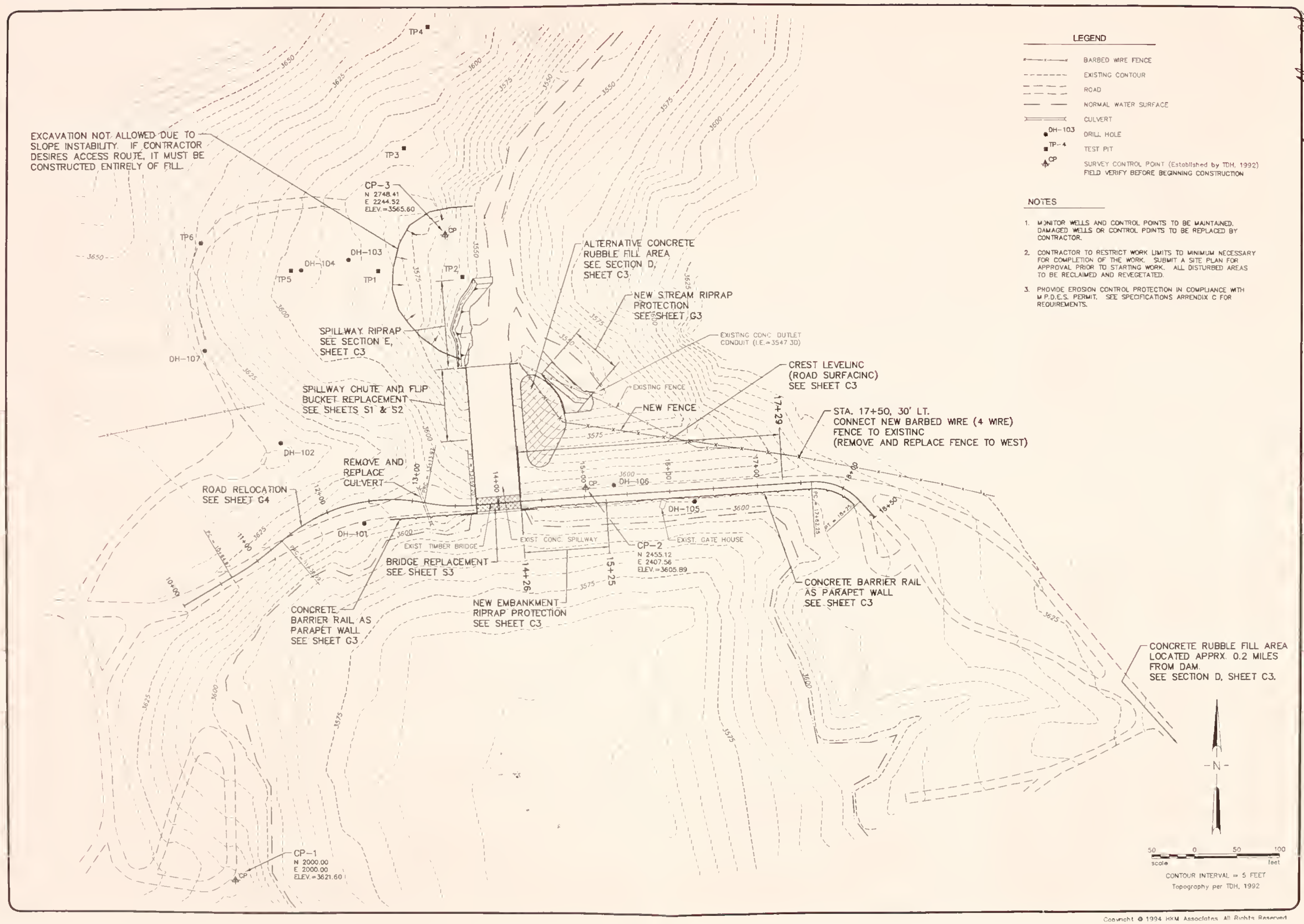
TP4
3650
3625
3600
3575
3550
EXCAVATION NOT ALLOWED DUE TO SLOPE INSTABILITY. IF CONTRACTOR DESIRES ACCESS ROUTE, IT MUST BE CONSTRUCTED ENTIRELY OF FILL.
TP3
CP-3 N 2748.41 E 2244.52 ELEV.=3565.60
TP6
DH-103
DH-104
TP5
TP1
TP2
ALTERNATIVE CONCRETE RUBBLE FILL AREA SEE SECTION D, SHEET C3
NEW STREAM RIPRAP PROTECTION SEE SHEET G3
EXISTING CONC. OUTLET CONDUIT (I.E.=3547.30)
SPILLWAY RIPRAP SEE SECTION E, SHEET C3
DH-107
CREST LEVELING (ROAD SURFACING) SEE SHEET C3
EXISTING FENCE
NEW FENCE
SPILLWAY CHUTE AND FLIP BUCKET REPLACEMENT SEE SHEETS S1 & S2
STA. 17+50, 30' LT. CONNECT NEW BARBED WIRE (4 WIRE) FENCE TO EXISTING (REMOVE AND REPLACE FENCE TO WEST)
17+29
DH-102
REMOVE AND REPLACE CULVERT
ROAD RELOCATION SEE SHEET G4
12+00
13+00
14+00
15+00
16+00
17+00
18+00
18+50
DH-106
DH-105
DH-101
11+00
10+00
EXIST. TIMBER BRIDGE
EXIST. CONC. SPILLWAY
EXIST. GATE HOUSE
CP-2 N 2455.12 E 2407.56 ELEV.=3605.89
BRIDGE REPLACEMENT SEE SHEET S3
14+26
15+25
CONCRETE BARRIER RAIL AS PARAPET WALL SEE SHEET C3
CONCRETE BARRIER RAIL AS PARAPET WALL SEE SHEET G3
NEW EMBANKMENT RIPRAP PROTECTION SEE SHEET C3
CONCRETE RUBBLE FILL AREA LOCATED APPRX. 0.2 MILES FROM DAM. SEE SECTION D, SHEET C3.
N
CP-1 N 2000.00 E 2000.00 ELEV.=3621.60
50 0 50 100
scale feet

CONTOUR INTERVAL = 5 FEET
Topography per TDH, 1992

LEGEND

—x—x—	BARBED WIRE FENCE
- - - - -	EXISTING CONTOUR
═ ═ ═	ROAD
—— ——	NORMAL WATER SURFACE
⊐══⊏	CULVERT
● DH-103	DRILL HOLE
■ TP-4	TEST PIT
⊕ CP	SURVEY CONTROL POINT (Established by TDH, 1992) FIELD VERIFY BEFORE BEGINNING CONSTRUCTION

NOTES

1. MONITOR WELLS AND CONTROL POINTS TO BE MAINTAINED. DAMAGED WELLS OR CONTROL POINTS TO BE REPLACED BY CONTRACTOR.
2. CONTRACTOR TO RESTRICT WORK LIMITS TO MINIMUM NECESSARY FOR COMPLETION OF THE WORK. SUBMIT A SITE PLAN FOR APPROVAL PRIOR TO STARTING WORK. ALL DISTURBED AREAS TO BE RECLAIMED AND REVEGETATED.
3. PROVIDE EROSION CONTROL PROTECTION IN COMPLIANCE WITH M.P.D.E.S. PERMIT. SEE SPECIFICATIONS APPENDIX C FOR REQUIREMENTS.

• Project No BM087.144 • G2 DWG • Date JULY 1994 • Designed • Drawn • Checked • Approved

No	Revision	By	Date
1	REBID		12/14/94

WARNING
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

BEARPAW LAKE DAM
HILL COUNTY, MONTANA

GENERAL SITE PLAN

HKM ASSOCIATES
ENGINEERS·PLANNERS
2727 Central Avenue
P.O. Box 31318
Billings, Montana 59107

Branch Offices:
• Sheridan, Wyoming
• Bozeman & Miles City, Montana

Sheet No.
G2
of 4

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SIGN LOCATIONS

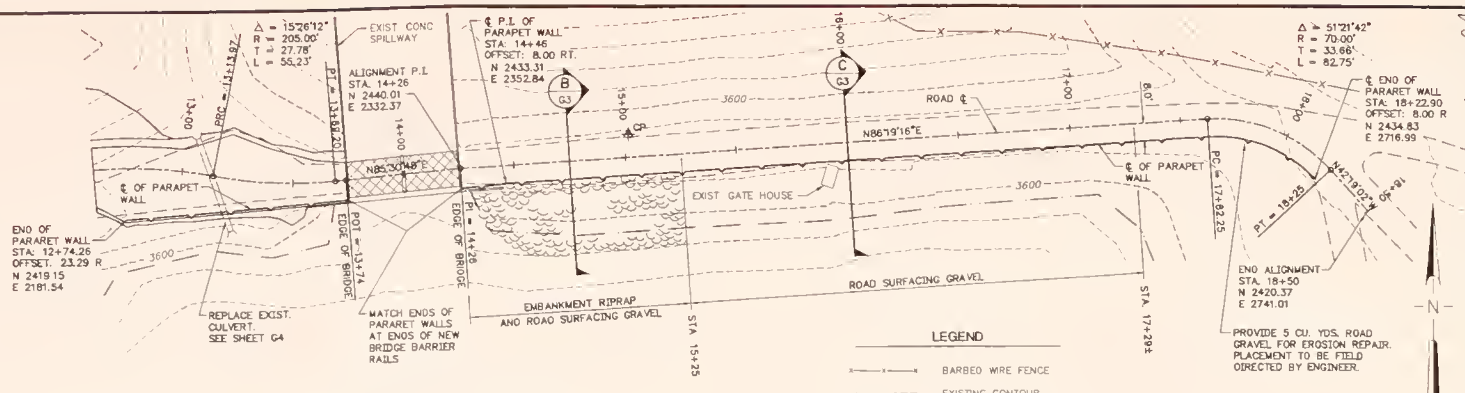
1. ROAD DELINEATORS DESIGN F, AT 45' SPACING, BOTH SIDES, STA. 14+50 TO STA. 18+00.
2. FOUR TYPE OM-3 OBJECT MARKERS (OWNER SUPPLIED) AT BRIDGE APPROACH RAILS AND AT ENDS OF PARAPET WALL.

SPILLWAY RIPRAP

SPILLWAY STATION	AREAS Square Feet		VOLUMES Cubic Yards		CUMULATIVE VOLUMES Cubic Yards	
		FILL		FILL		FILL
2+12		0		3.19		3
2+20		21.6		9.19		12
2+30		28.1		11.26		24
2+40		32.8		13.64		37
2+50		40.9		14.53		52
2+60		37.6		11.94		64
2+70		26.9		9.68		73
2+80		25.3		11.09		85
2+90		34.6		13.27		98
3+00		37.1		8.24		106
3+12		0		0		106

STREAM RIPRAP

STATION	AREAS Square Feet		VOLUMES Cubic Yards		CUMULATIVE VOLUMES Cubic Yards	
		FILL		FILL		FILL
0+00		37.9		13.91		14
0+10		37.2		13.83		28
0+20		37.5		14.02		42
0+30		38.2		14.39		56
0+40		39.5		14.80		71
0+50		40.4		15.19		86
0+60		41.6		0		86



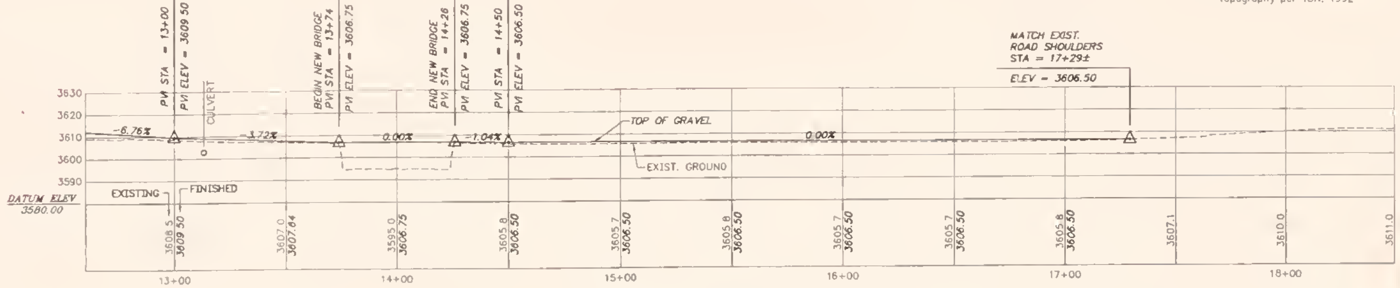
DAM IMPROVEMENTS PLAN

LEGEND

—x—x—	BARBED WIRE FENCE
- - - -	EXISTING CONTOUR
— — —	ROAD
— · —	NORMAL WATER SURFACE
>===<	CULVERT
⊕ CP	SURVEY CONTROL POINT

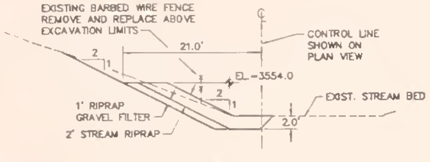
30 0 30 60
scale feet

CONTOUR INTERVAL = 5 FEET
Topography per TDH, 1992



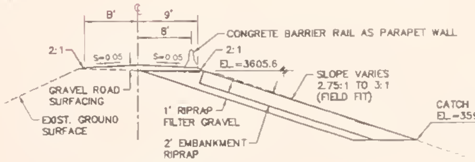
DAM IMPROVEMENTS PROFILE AT ℄

30 0 30 60
scale feet


EXISTING BARBED WIRE FENCE REMOVE AND REPLACE ABOVE EXCAVATION LIMITS
℄
CONTROL LINE SHOWN ON PLAN VIEW
21.0'
2
1
EL.=3554.0
2
1
EXIST. STREAM BED
1' RIPRAP GRAVEL FILTER
2' STREAM RIPRAP
2.0'

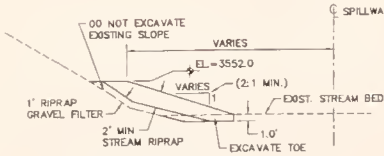
A / G3 SECTION
STREAM RIPRAP

10 0 10 20
scale feet



B / G3 SECTION
EMBANKMENT RIPRAP

10 0 10 20
scale feet

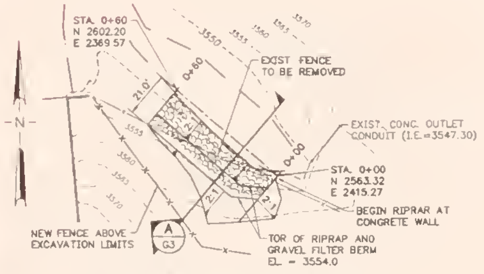


E / G3 SECTION
SPILLWAY RIPRAP

10 0 10 20
scale feet

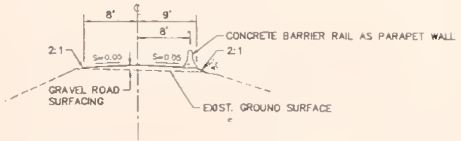
EMBANKMENT RIPRAP

STATION	AREAS Square Feet		VOLUMES Cubic Yards		CUMULATIVE VOLUMES Cubic Yards	
		FILL		FILL		FILL
14+26		0.00		20.21		20
14+45		57.44		10.67		31
14+50		58.77		55.50		86
14+75		61.12		56.32		143
15+00		60.54		55.48		198
15+25		59.30		0		198


STA. 0+60
N 2602.20
E 2369.57
3550
3555
3560
3565
3570
EXIST FENCE TO BE REMOVED
0+60
21.0'
N
EXIST. CONC. OUTLET CONDUIT (I.E.=3547.30)
0+00
STA. 0+00
N 2563.32
E 2415.27
BEGIN RIPRAP AT CONCRETE WALL
2:1
2:1
NEW FENCE ABOVE EXCAVATION LIMITS
A
G3
TOP OF RIPRAP AND GRAVEL FILTER BERM EL. = 3554.0

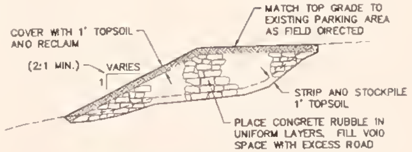
STREAM RIPRAP PROTECTION PLAN

30 0 30 60
scale feet



C / G3 SECTION
ROAD SURFACING

10 0 10 20
scale feet


MATCH TOP GRADE TO EXISTING PARKING AREA AS FIELD DIRECTED
COVER WITH 1' TOPSOIL AND RECLAIM
(2:1 MIN.)
VARIES
1
STRIP AND STOCKPILE 1' TOPSOIL
PLACE CONCRETE RUBBLE IN UNIFORM LAYERS. FILL VOID SPACE WITH EXCESS ROAD EXCAVATION

D / G3 SECTION
CONCRETE RUBBLE FILL

ROAD SURFACING GRAVEL

STATION	AREAS Square Feet		VOLUMES Cubic Yards		CUMULATIVE VOLUMES Cubic Yards	
		FILL		FILL		FILL
14+26		12.48		7.99		8
14+45		10.24		1.84		10
14+50		9.62		9.28		19
14+75		10.42		9.59		29
15+00		10.30		9.20		38
15+25		9.58		8.47		46
15+50		8.71		8.69		55
15+75		10.07		9.44		65
16+00		10.32		9.68		74
16+25		10.59		9.90		84
16+50		10.79		9.92		94
16+75		10.64		10.25		104
17+00		9.86		4.86		109
17+25		0.64		0.06		109
17+29		0.18		0		109
EROSION REPAIR				5		114

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● Project No. 8M087 144 ● G3 DWG ● Date JULY 1994 ● Designed ● Drawn ● Checked ● Approved

No	Revision	By	Date
1	REBID		12/14/94

WARNING
0 ½ 1
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BEARPAW LAKE DAM
HILL COUNTY, MONTANA

DAM IMPROVEMENT PLAN, SECTIONS AND DETAILS

6396
PROFESSIONAL

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· Sheridan, Wyoming
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G3
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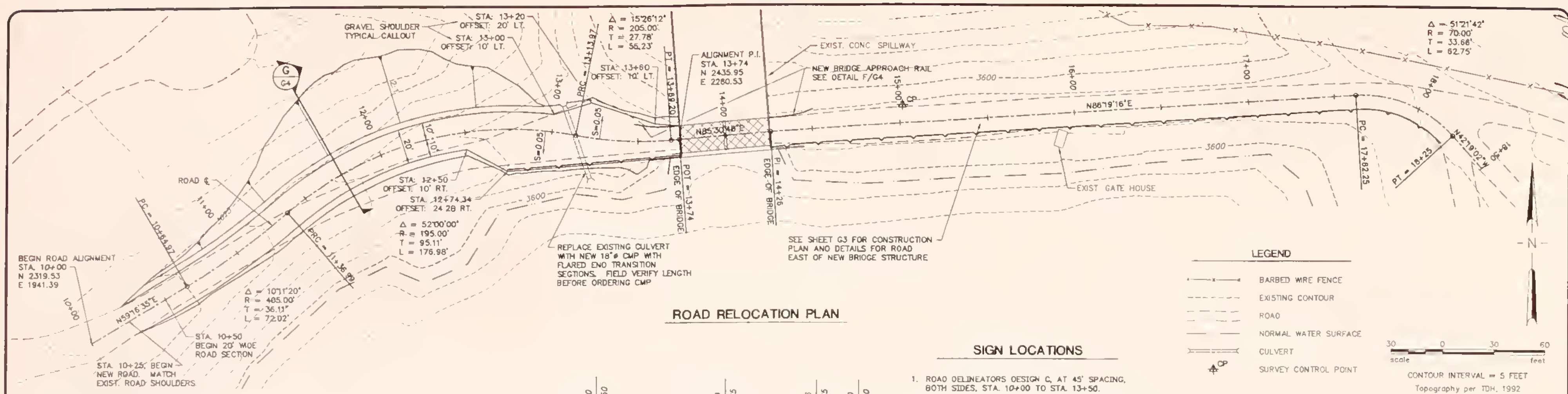
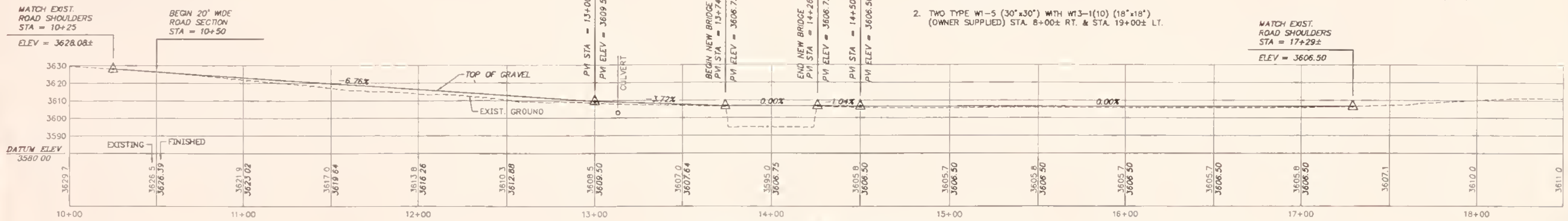

GRAVEL SHOULDER TYPICAL CALLOUT
STA: 13+20 OFFSET: 20' LT.
STA: 13+00 OFFSET: 10' LT.
Δ = 15°26'12" R = 205.00' T = 27.78' L = 55.23'
PRC = 13+13.97
PI = 13+69.20
STA: 13+60 OFFSET: 10' LT.
ALIGNMENT P.I. STA. 13+74 N 2435.95 E 2280.53
EXIST. CONC. SPILLWAY
NEW BRIDGE APPROACH RAIL SEE DETAIL F/G4
N85°30'48"E
N88°19'16"E
EDGE OF BRIDGE
POT = 13+74
PI = 14+26
EDGE OF BRIDGE
12+00
13+00
14+00
15+00
16+00
17+00
18+00
18+50
3600
20'
10' 10'
S=0.05
ROAD ℄
11+00
10+00
PC = 10+64.97
PRC = 11+36.99
STA: 12+50 OFFSET: 10' RT.
STA: 12+74.34 OFFSET: 24.28 RT.
Δ = 52°00'00" R = 195.00' T = 95.11' L = 176.98'
REPLACE EXISTING CULVERT WITH NEW 18"ø CMP WITH FLARED END TRANSITION SECTIONS. FIELD VERIFY LENGTH BEFORE ORDERING CMP
SEE SHEET G3 FOR CONSTRUCTION PLAN AND DETAILS FOR ROAD EAST OF NEW BRIDGE STRUCTURE
EXIST. GATE HOUSE
CP
PC = 17+82.25
PT = 18+25
N42°19'02"W
Δ = 51°21'42" R = 70.00' T = 33.68' L = 62.75'
BEGIN ROAD ALIGNMENT STA. 10+00 N 2319.53 E 1941.39
N59°16'35"E
Δ = 10°11'20" R = 405.00' T = 36.11' L = 72.02'
STA. 10+50 BEGIN 20' WIDE ROAD SECTION
STA. 10+25, BEGIN NEW ROAD. MATCH EXIST. ROAD SHOULDERS
G/G4
N
LEGEND
BARBED WIRE FENCE
EXISTING CONTOUR
ROAD
NORMAL WATER SURFACE
CULVERT
SURVEY CONTROL POINT
30 0 30 60 scale feet
CONTOUR INTERVAL = 5 FEET
Topography per TDH, 1992

ROAD RELOCATION PLAN

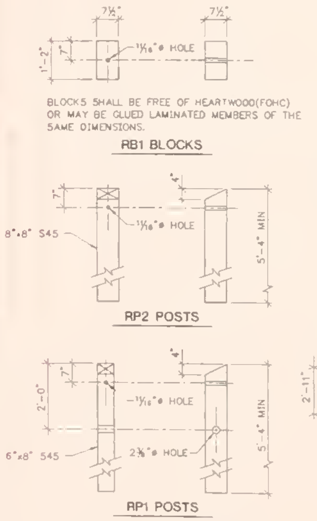
SIGN LOCATIONS

1. ROAD DELINEATORS DESIGN C, AT 45' SPACING, BOTH SIDES, STA. 10+00 TO STA. 13+50.
2. TWO TYPE W1-5 (30"x30") WITH W13-1(10) (18"x18") (OWNER SUPPLIED) STA. 8+00± RT. & STA. 19+00± LT.



ROAD RELOCATION PROFILE AT ℄

30 0 30 60
scale feet



BLOCKS SHALL BE FREE OF HEARTWOOD(FOHC) OR MAY BE GLUED LAMINATED MEMBERS OF THE SAME DIMENSIONS.

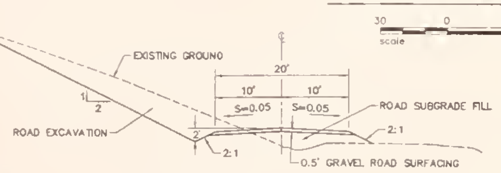
RB1 BLOCKS

RP2 POSTS

RP1 POSTS

POST & BLOCK DETAILS

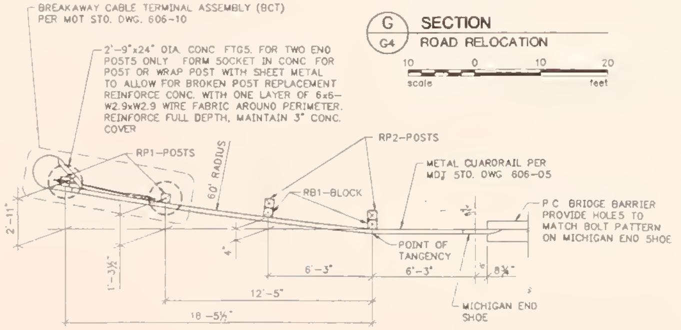
NOT TO SCALE



G/G4 SECTION

ROAD RELOCATION

10 0 10 20
scale feet


BREAKAWAY CABLE TERMINAL ASSEMBLY (BCT) PER MDT STD. DWG. 606-10
2'-9"x24" DIA. CONC. FTGS. FOR TWO END POSTS ONLY. FORM SOCKET IN CONC. FOR POST OR WRAP POST WITH SHEET METAL TO ALLOW FOR BROKEN POST REPLACEMENT. REINFORCE CONC. WITH ONE LAYER OF 6x6-W2.9xW2.9 WIRE FABRIC AROUND PERIMETER. REINFORCE FULL DEPTH, MAINTAIN 3" CONC. COVER
RP1-POSTS
RP2-POSTS
60' RADIUS
RB1-BLOCK
METAL GUARDRAIL PER MDT STD. DWG. 606-05
P.C. BRIDGE BARRIER PROVIDE HOLES TO MATCH BOLT PATTERN ON MICHIGAN END SHOE
POINT OF TANGENCY
MICHIGAN END SHOE
2'-11"
1'-3½"
4"
6'-3"
6'-3"
8¾"
12'-5"
18'-5½"

F/G4 DETAIL

APPROACH RAIL

NOT TO SCALE

ROAD RELOCATION - ROAD SURFACING GRAVEL

STATION	AREAS Square Feet		VOLUMES Cubic Yards		CUMULATIVE VOLUMES Cubic Yards	
		FILL		FILL		FILL
10+25		10.29		9.53		10
10+50		10.29		5.91		15
10+64.97		11.06		4.07		20
10+75		10.86		9.92		29
11+00		10.57		9.79		39
11+25		10.57		4.69		44
11+36.99		10.57		5.09		49
11+50		10.57		9.79		59
11+75		10.57		9.79		69
12+00		10.57		9.79		78
12+25		10.57		9.79		88
12+50		10.57		13.08		101
12+75		17.89		15.56		117
13+00		15.91		8.80		126
13+13.97		18.12		7.31		133
13+25		17.67		13.94		147
13+50		12.45		8.12		156
13+69.20		13.40		2.02		158
13+74		9.34		0.00		158

ROAD RELOCATION - EARTHWORK

STATION	AREAS Square Feet		VOLUMES Cubic Yards		CUMULATIVE VOLUMES Cubic Yards	
	CUT	FILL	CUT	FILL	CUT	FILL
10+25	16.84	0.00	14.66	0.00	15	0
10+50	14.83	0.00	6.43	0.00	21	0
10+64.97	8.35	0.00	2.20	0.00	23	0
10+75	3.50	0.00	2.86	6.81	26	7
11+00	2.68	10.40	6.55	15.62	33	22
11+25	11.63	23.41	7.51	11.03	40	33
11+36.99	21.52	26.14	12.94	12.96	53	46
11+50	41.94	28.06	48.94	25.58	100	72
11+75	113.02	27.92	81.42	25.40	182	97
12+00	173.42	27.83	81.75	23.37	263	120
12+25	136.81	23.55	73.52	21.74	337	143
12+50	87.55	24.28	49.24	24.19	386	167
12+75	18.80	27.98	11.14	17.72	397	184
13+00	5.26	10.29	1.65	5.55	399	190
13+13.97	1.11	11.18	0.32	4.47	399	194
13+25	0.48	10.70	0.73	8.44	400	203
13+50	1.10	7.53	1.53	3.34	401	206
13+69.20	3.20	1.86	0.28	1.03	402	207
13+74	0.00	9.71	0.00	0.00	402	207

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• Project No. BM087.144 • G4 DWG • Date JULY 1994 • Designed • Drawn • Checked • Approved

No	Revision	By	Date
1	REBID		12/14/94

WARNING
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

BEARPAW LAKE DAM
HILL COUNTY, MONTANA

ROAD RELOCATION PLAN, PROFILE AND SECTIONS

HKM ASSOCIATES
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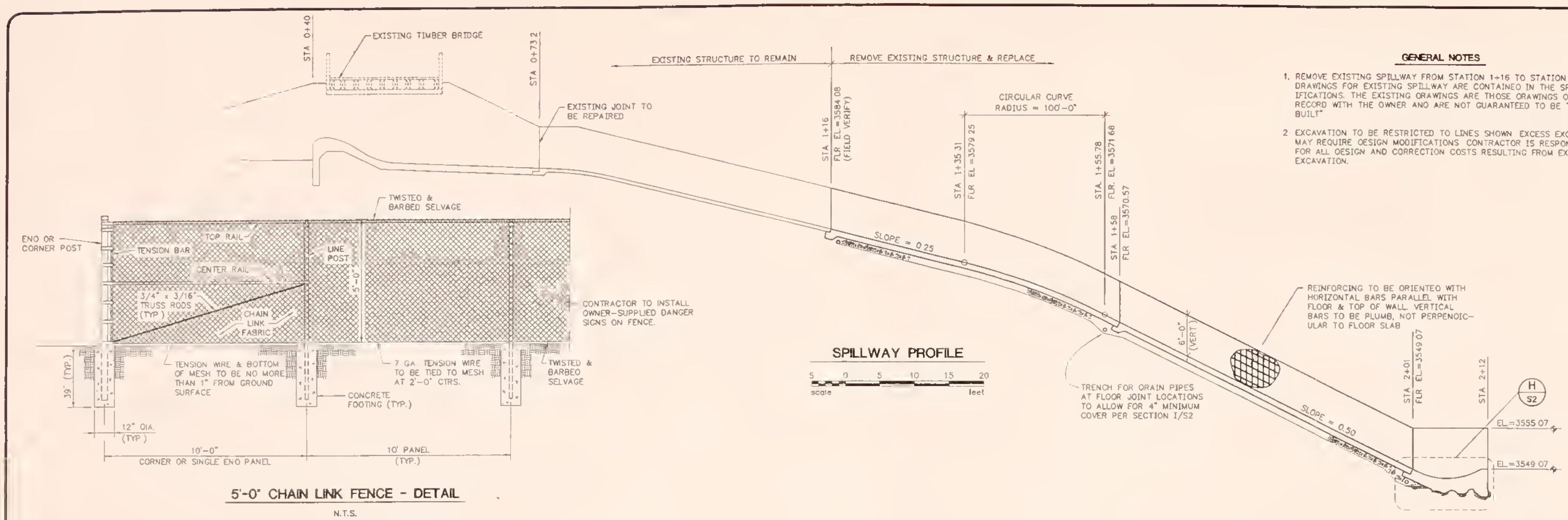

STA 0+40
EXISTING TIMBER BRIDGE
STA 0+73.2
EXISTING JOINT TO BE REPAIRED
EXISTING STRUCTURE TO REMAIN
REMOVE EXISTING STRUCTURE & REPLACE
STA 1+16
FLR EL =3584.08 (FIELD VERIFY)
CIRCULAR CURVE RADIUS = 100'-0"
STA 1+35.31
FLR EL =3579.25
STA 1+55.78
FLR EL =3571.68
STA 1+58
FLR EL =3570.57
SLOPE = 0.25
6'-0" (VERT)
TRENCH FOR DRAIN PIPES AT FLOOR JOINT LOCATIONS TO ALLOW FOR 4" MINIMUM COVER PER SECTION I/S2
REINFORCING TO BE ORIENTED WITH HORIZONTAL BARS PARALLEL WITH FLOOR & TOP OF WALL. VERTICAL BARS TO BE PLUMB, NOT PERPENDICULAR TO FLOOR SLAB
STA 2+01
FLR EL =3549.07
STA 2+12
H S2
SLOPE = 0.50
EL.=3555.07
EL.=3549.07
5 0 5 10 15 20
scale feet
END OR CORNER POST
TWISTED & BARBED SELVAGE
TOP RAIL
TENSION BAR
CENTER RAIL
LINE POST
3/4" x 3/16" TRUSS RODS (TYP.)
CHAIN LINK FABRIC
5'-0"
CONTRACTOR TO INSTALL OWNER-SUPPLIED DANGER SIGNS ON FENCE.
3.9' (TYP.)
TENSION WIRE & BOTTOM OF MESH TO BE NO MORE THAN 1" FROM GROUND SURFACE
7 GA. TENSION WIRE TO BE TIED TO MESH AT 2'-0" CTRS.
TWISTED & BARBED SELVAGE
CONCRETE FOOTING (TYP.)
12" DIA. (TYP.)
10'-0"
CORNER OR SINGLE END PANEL
10' PANEL (TYP.)

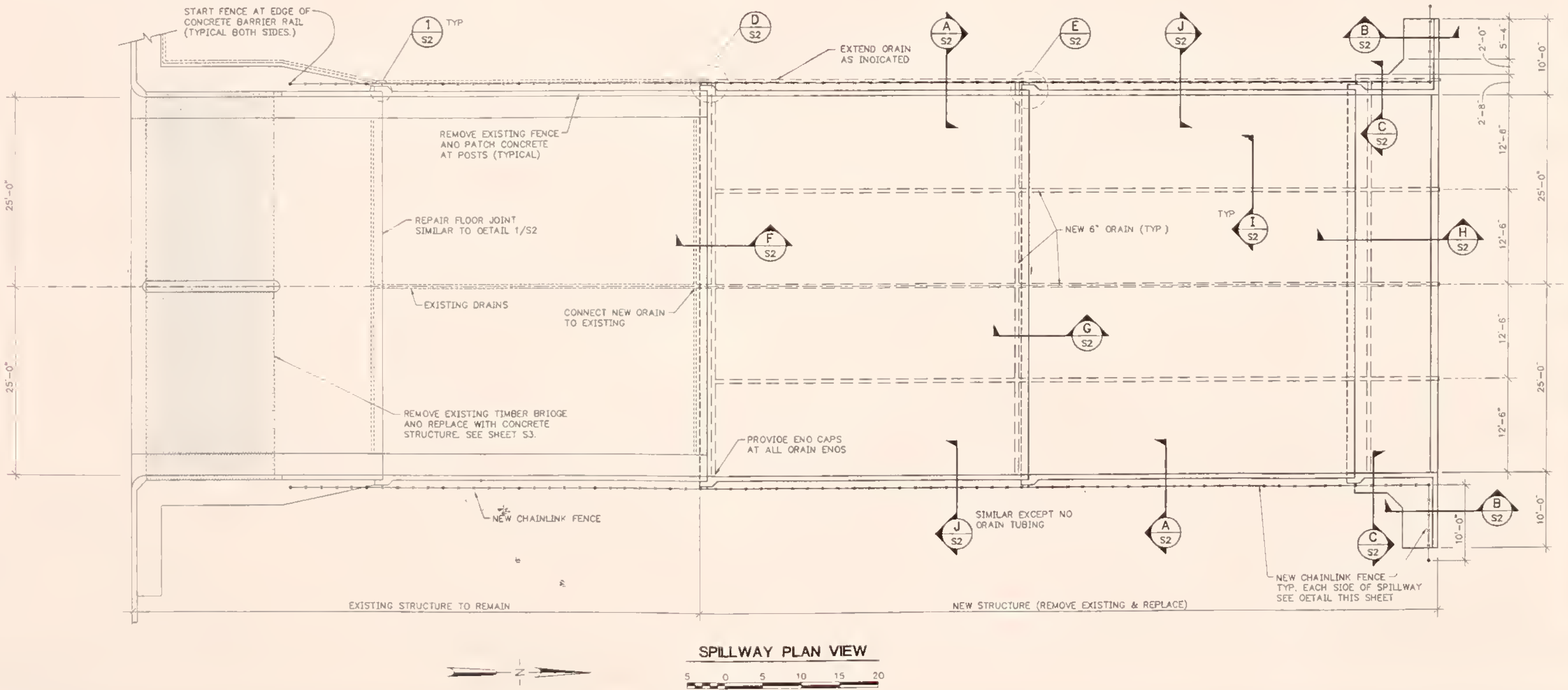
SPILLWAY PROFILE

5'-0" CHAIN LINK FENCE - DETAIL

N.T.S.

GENERAL NOTES

1. REMOVE EXISTING SPILLWAY FROM STATION 1+16 TO STATION 2+12. DRAWINGS FOR EXISTING SPILLWAY ARE CONTAINED IN THE SPECIFICATIONS. THE EXISTING DRAWINGS ARE THOSE DRAWINGS ON RECORD WITH THE OWNER AND ARE NOT GUARANTEED TO BE "AS BUILT"
2. EXCAVATION TO BE RESTRICTED TO LINES SHOWN. EXCESS EXCAVATION MAY REQUIRE DESIGN MODIFICATIONS. CONTRACTOR IS RESPONSIBLE FOR ALL DESIGN AND CORRECTION COSTS RESULTING FROM EXCESS EXCAVATION.


START FENCE AT EDGE OF CONCRETE BARRIER RAIL (TYPICAL BOTH SIDES.)
1 S2 TYP
D S2
EXTEND DRAIN AS INDICATED
A S2
E S2
J S2
B S2
C S2
REMOVE EXISTING FENCE AND PATCH CONCRETE AT POSTS (TYPICAL)
REPAIR FLOOR JOINT SIMILAR TO DETAIL 1/S2
F S2
NEW 6" DRAIN (TYP.)
TYP I S2
H S2
EXISTING DRAINS
CONNECT NEW DRAIN TO EXISTING
G S2
REMOVE EXISTING TIMBER BRIDGE AND REPLACE WITH CONCRETE STRUCTURE. SEE SHEET S3.
PROVIDE END CAPS AT ALL DRAIN ENDS
NEW CHAINLINK FENCE
SIMILAR EXCEPT NO DRAIN TUBING
NEW CHAINLINK FENCE TYP. EACH SIDE OF SPILLWAY SEE DETAIL THIS SHEET
25'-0"
25'-0"
2'-0"
5'-4"
10'-0"
2'-8"
12'-8"
12'-6"
12'-6"
12'-6"
25'-0"
25'-0"
10'-0"
10'-0"
EXISTING STRUCTURE TO REMAIN
NEW STRUCTURE (REMOVE EXISTING & REPLACE)
N
5 0 5 10 15 20
scale feet

SPILLWAY PLAN VIEW

● Project No. 8M087.144 ● S1.DWG ● Date JULY 1994 ● Designed GJ ● Drawn DMN ● Checked PHOM ● Approved DF

No.	Revision	By	Date

WARNING
0 ½ 1
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BEARPAW LAKE DAM
HILL COUNTY, MONTANA

SPILLWAY PLAN AND PROFILE

GARY R. SIMONICH

HKM ASSOCIATES
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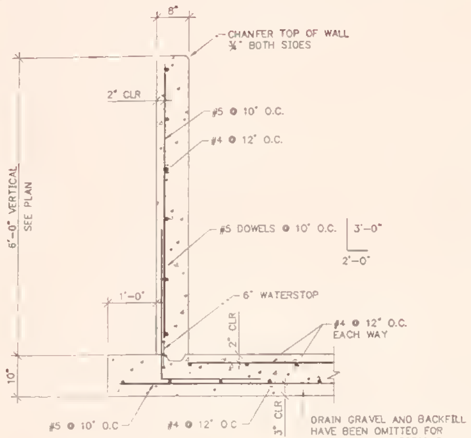
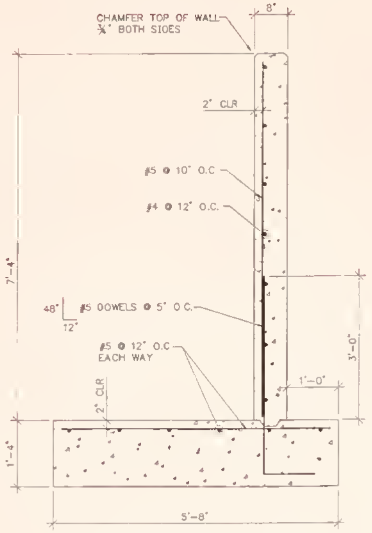
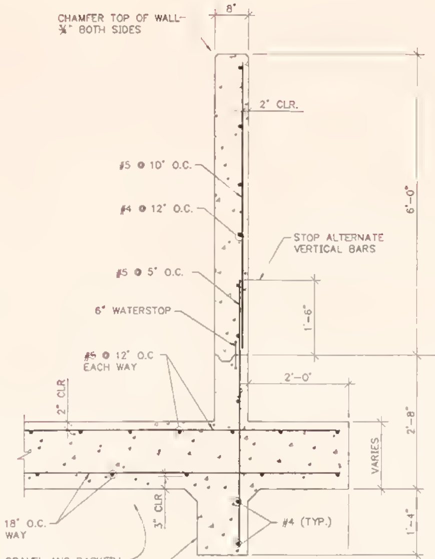


A S2 **SECTION**
TYPICAL WALL
scale 1 0 1 2 3 feet



NOTE: DRAIN GRAVEL AND BACKFILL HAVE BEEN OMITTED FOR CLARITY. SEE SECTIONS I/S2 & J/S2

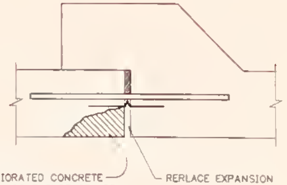
B S2 **SECTION**
TYPICAL WING WALL
scale 1 0 1 2 3 feet



DRAIN GRAVEL AND BACKFILL HAVE BEEN OMITTED FOR CLARITY. SEE SECTIONS I/S2 & J/S2

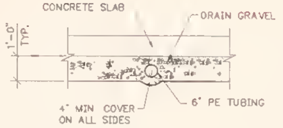
KEYWAY EXTENDS FROM STA. 2+04 TO STA. 2+12

C S2 **SECTION**
SPILLWAY WALL @ FLIP BUCKET
scale 1 0 1 2 3 feet

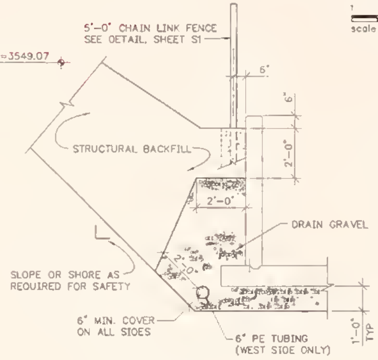


REMOVE SPALLING AND DETERIORATED CONCRETE TO SOUND DURABLE MATERIAL. COAT SURFACE WITH BONDING AGENT AND REBUILD AREA W/NON-SHRINK GROUT. BONDING AGENT TO BE SIKADUR 32. GROUT TO BE SIKATOP 123 OR APPROVED EQUALS. INSTALL PER MANUFACTURERS PRINTED INSTRUCTIONS.

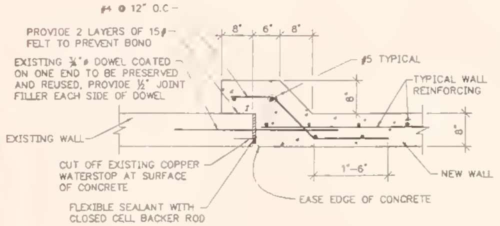
1 S2 **DETAIL**
WALL JOINT REPAIR
scale 1 0 1 feet



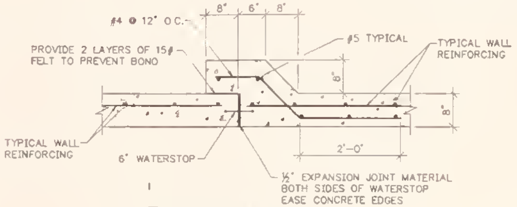
I S2 **SECTION**
TYPICAL FLOOR DRAIN
scale 1 0 1 2 3 4 5 6 7 feet


5'-0" CHAIN LINK FENCE SEE DETAIL, SHEET S1
6"
6"
STRUCTURAL BACKFILL
2'-0"
2'-0"
DRAIN GRAVEL
SLOPE OR SHORE AS REQUIRED FOR SAFETY
6" MIN. COVER ON ALL SIDES
6" PE TUBING (WEST SIDE ONLY)
1'-0" TYP.

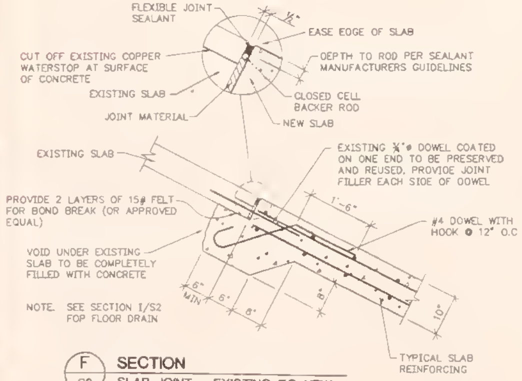
J S2 **SECTION**
TYPICAL WALL DRAIN
scale 1 0 1 2 3 4 5 6 7 feet


#4 @ 12" O.C.
PROVIDE 2 LAYERS OF 15# FELT TO PREVENT BOND
8"
6"
8"
#5 TYPICAL
EXISTING ¾"⌀ DOWEL COATED ON ONE END TO BE PRESERVED AND REUSED. PROVIDE ½" JOINT FILLER EACH SIDE OF DOWEL
TYPICAL WALL REINFORCING
8"
EXISTING WALL
8"
1'-6"
CUT OFF EXISTING COPPER WATERSTOP AT SURFACE OF CONCRETE
NEW WALL
FLEXIBLE SEALANT WITH CLOSED CELL BACKER ROD
EASE EDGE OF CONCRETE

D S2 **SECTION**
WALL JOINT - EXISTING TO NEW
scale 1 0 1 2 3 feet

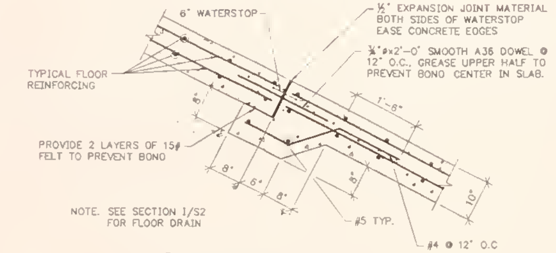

#4 @ 12" O.C.
8"
6"
8"
PROVIDE 2 LAYERS OF 15# FELT TO PREVENT BOND
#5 TYPICAL
TYPICAL WALL REINFORCING
8"
8"
TYPICAL WALL REINFORCING
6" WATERSTOP
2'-0"
½" EXPANSION JOINT MATERIAL BOTH SIDES OF WATERSTOP EASE CONCRETE EDGES

E S2 **SECTION**
TYPICAL WALL JOINT
scale 1 0 1 2 3 feet


FLEXIBLE JOINT SEALANT
¼"
EASE EDGE OF SLAB
CUT OFF EXISTING COPPER WATERSTOP AT SURFACE OF CONCRETE
DEPTH TO ROD PER SEALANT MANUFACTURERS GUIDELINES
EXISTING SLAB
CLOSED CELL BACKER ROD
JOINT MATERIAL
NEW SLAB
EXISTING SLAB
EXISTING ¾"⌀ DOWEL COATED ON ONE END TO BE PRESERVED AND REUSED. PROVIDE JOINT FILLER EACH SIDE OF DOWEL
PROVIDE 2 LAYERS OF 15# FELT FOR BOND BREAK (OR APPROVED EQUAL)
1'-6"
#4 DOWEL WITH HOOK @ 12" O.C.
VOID UNDER EXISTING SLAB TO BE COMPLETELY FILLED WITH CONCRETE
6" MIN.
6"
6"
8"
10"
TYPICAL SLAB REINFORCING

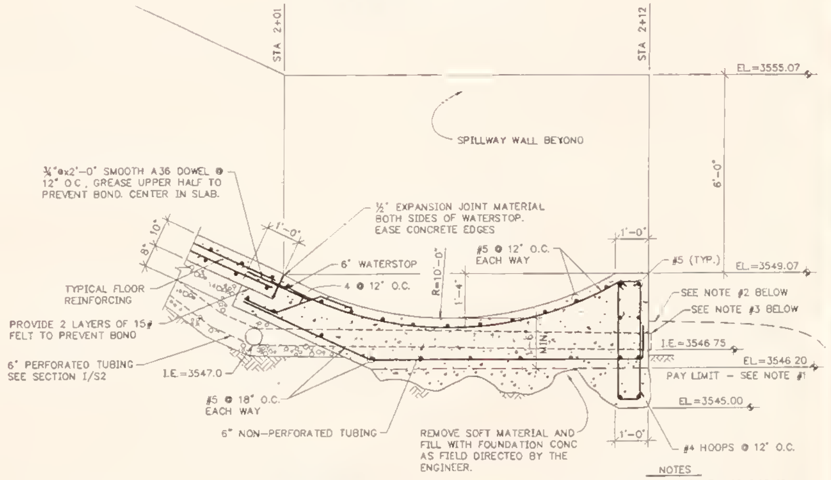
NOTE: SEE SECTION I/S2 FOR FLOOR DRAIN

F S2 **SECTION**
SLAB JOINT - EXISTING TO NEW
scale 1 0 1 2 3 feet


6" WATERSTOP
½" EXPANSION JOINT MATERIAL BOTH SIDES OF WATERSTOP EASE CONCRETE EDGES
¾"⌀x2'-0" SMOOTH A36 DOWEL @ 12" O.C., GREASE UPPER HALF TO PREVENT BOND. CENTER IN SLAB.
TYPICAL FLOOR REINFORCING
1'-6"
8"
PROVIDE 2 LAYERS OF 15# FELT TO PREVENT BOND
8"
6"
8"
8"
10"
#5 TYP.
#4 @ 12" O.C.

NOTE: SEE SECTION I/S2 FOR FLOOR DRAIN

G S2 **SECTION**
TYPICAL FLOOR JOINT
scale 1 0 1 2 3 feet


STA. 2+01
STA. 2+12
EL.=3555.07
SPILLWAY WALL BEYOND
6'-0"
¾"⌀x2'-0" SMOOTH A36 DOWEL @ 12" O.C., GREASE UPPER HALF TO PREVENT BOND. CENTER IN SLAB.
½" EXPANSION JOINT MATERIAL BOTH SIDES OF WATERSTOP. EASE CONCRETE EDGES
10"
1'-0"
6" WATERSTOP
#5 @ 12" O.C. EACH WAY
1'-0"
#5 (TYP.)
EL.=3549.07
TYPICAL FLOOR REINFORCING
#4 @ 12" O.C.
R=10'-0"
1'-4"
SEE NOTE #2 BELOW
SEE NOTE #3 BELOW
PROVIDE 2 LAYERS OF 15# FELT TO PREVENT BOND
I.E.=3546.75
EL.=3546.20
6" PERFORATED TUBING SEE SECTION I/S2
I.E.=3547.0
PAY LIMIT - SEE NOTE #1
#5 @ 18" O.C. EACH WAY
EL.=3545.00
6" NON-PERFORATED TUBING
REMOVE SOFT MATERIAL AND FILL WITH FOUNDATION CONC AS FIELD DIRECTED BY THE ENGINEER.
1'-0"
#4 HOOPS @ 12" O.C.

H S2 **SECTION**
FLIP BUCKET
scale 1 0 1 2 3 4 5 feet

NOTES
1) CONCRETE PLACED BELOW EL. 3546.20 IS PAID AS FOUNDATION CONCRETE. CONCRETE PLACED ABOVE EL. 3546.20 IS PAID AS SPILLWAY CONCRETE.
2) EXCAVATE TRENCH TO PROVIDE DRAINAGE IF ROCK IS ABOVE INVERT OF DRAIN PIPE.
3) INSTALL GALVANIZED HARDWARE CLOTH OVER DRAIN END. SECURE WITH 4 STAINLESS STEEL ANCHOR BOLTS AT EACH DRAIN.

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16

No.	Revision	By	Date

WARNING
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

• Project No. 8M087.144 • S2.DWG • Date JULY 1994 • Designed • Drawn DNM • Checked • Approved

BEARPAW LAKE DAM
HILL COUNTY, MONTANA

SPILLWAY DETAILS

GARY R. [illegible]

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Branch Offices:
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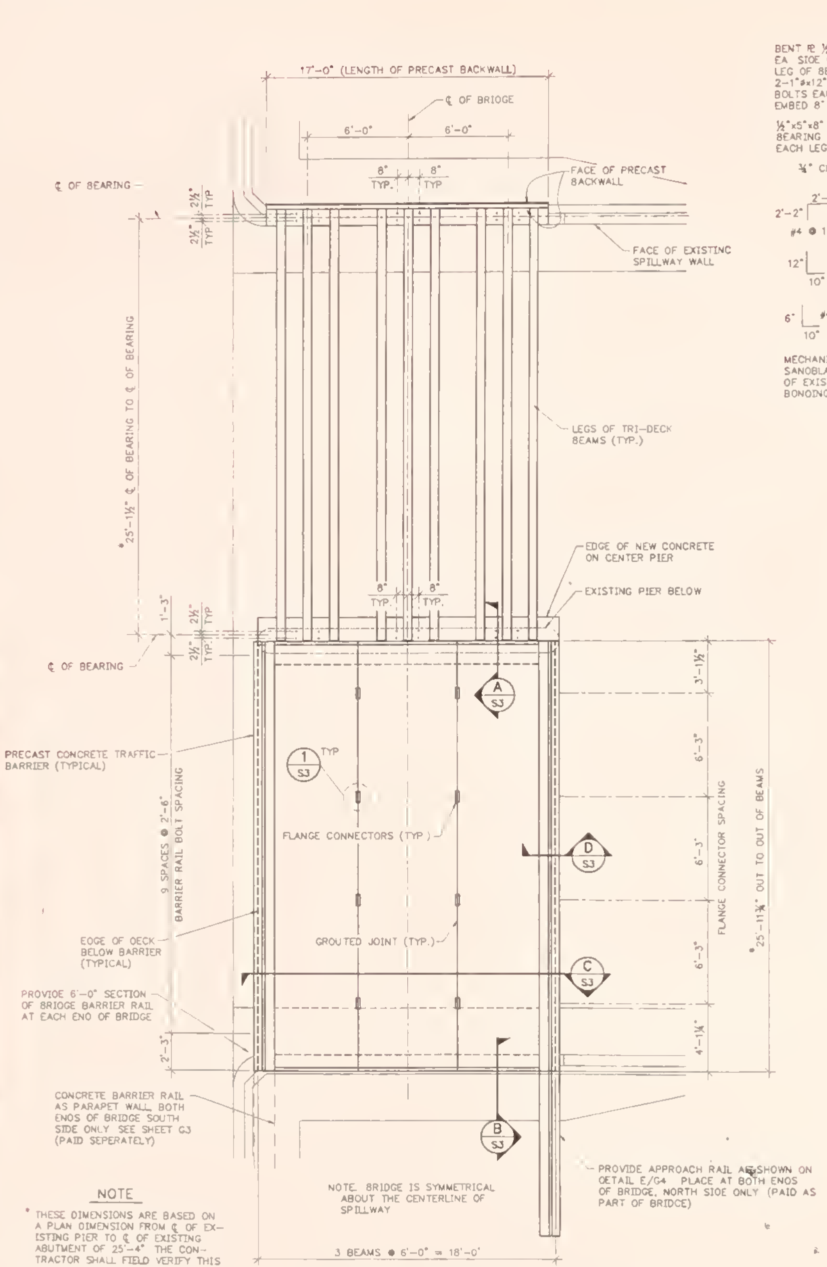
Sheet No
S2
of 3

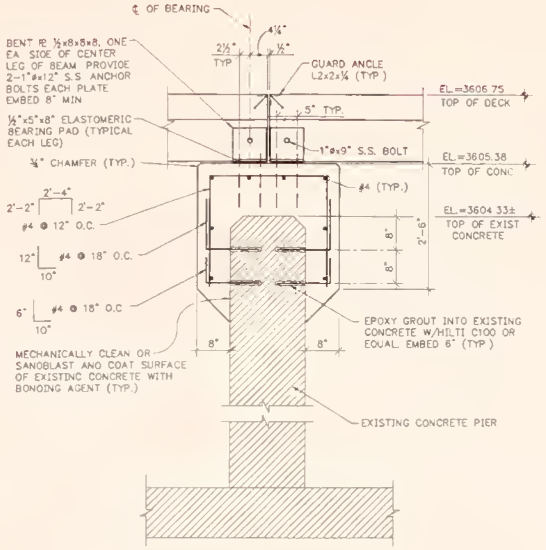

17'-0" (LENGTH OF PRECAST BACKWALL)
℄ OF BRIDGE
6'-0"
6'-0"
8" TYP.
8" TYP
FACE OF PRECAST BACKWALL
℄ OF BEARING
2½" TYP
2½" TYP
FACE OF EXISTING SPILLWAY WALL
* 25'-1½" ℄ OF BEARING TO ℄ OF BEARING
LEGS OF TRI-DECK BEAMS (TYP.)
EDGE OF NEW CONCRETE ON CENTER PIER
EXISTING PIER BELOW
8" TYP.
8" TYP.
1'-3"
℄ OF BEARING
3'-1½"
6'-3"
6'-3"
6'-3"
4'-1½"
2'-3"
FLANGE CONNECTOR SPACING
* 25'-11¾" OUT TO OUT OF BEAMS
PRECAST CONCRETE TRAFFIC BARRIER (TYPICAL)
9 SPACES @ 2'-6" BARRIER RAIL BOLT SPACING
1 S3 TYP
A S3
D S3
C S3
B S3
FLANGE CONNECTORS (TYP.)
GROUTED JOINT (TYP.)
EDGE OF DECK BELOW BARRIER (TYPICAL)
PROVIDE 6'-0" SECTION OF BRIDGE BARRIER RAIL AT EACH END OF BRIDGE
CONCRETE BARRIER RAIL AS PARAPET WALL, BOTH ENDS OF BRIDGE SOUTH SIDE ONLY. SEE SHEET G3 (PAID SEPERATELY)
NOTE: BRIDGE IS SYMMETRICAL ABOUT THE CENTERLINE OF SPILLWAY
PROVIDE APPROACH RAIL AS SHOWN ON DETAIL E/G4. PLACE AT BOTH ENDS OF BRIDGE, NORTH SIDE ONLY (PAID AS PART OF BRIDGE)
3 BEAMS @ 6'-0" = 18'-0"
N

NOTE

* THESE DIMENSIONS ARE BASED ON A PLAN DIMENSION FROM ℄ OF EXISTING PIER TO ℄ OF EXISTING ABUTMENT OF 25'-4". THE CONTRACTOR SHALL FIELD VERIFY THIS DIMENSION FOR BOTH ABUTMENTS BEFORE BEGINNING WORK AND NOTIFY THE ENGINEER OF A DISCREPANCY GREATER THAN 1 INCH.

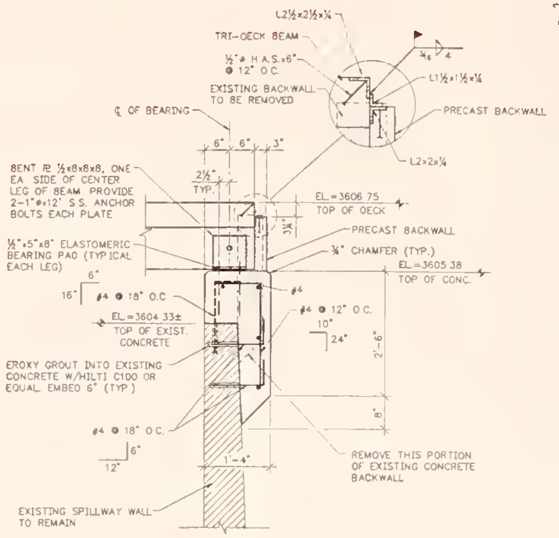
PLAN VIEW OF BRIDGE

2 0 2 4 6 8 10
scale feet


℄ OF BEARING
4¼"
2½" TYP
½"
BENT ℙ ½x8x8x8, ONE EA. SIDE OF CENTER LEG OF BEAM. PROVIDE 2-1"ϕx12" S.S. ANCHOR BOLTS EACH PLATE. EMBED 8" MIN
GUARD ANGLE L2x2x¼ (TYP.)
EL.=3606.75 TOP OF DECK
5" TYP.
½"x5"x8" ELASTOMERIC BEARING PAD (TYPICAL EACH LEG)
1"ϕx9" S.S. BOLT
EL.=3605.38 TOP OF CONC
¾" CHAMFER (TYP.)
#4 (TYP.)
2'-4"
2'-2"
2'-2"
#4 @ 12" O.C.
EL.=3604.33± TOP OF EXIST CONCRETE
12"
#4 @ 18" O.C.
10"
8"
8"
2'-6"
6"
#4 @ 18" O.C.
10"
8"
8"
EPOXY GROUT INTO EXISTING CONCRETE W/HILTI C100 OR EQUAL. EMBED 6" (TYP.)
MECHANICALLY CLEAN OR SANDBLAST AND COAT SURFACE OF EXISTING CONCRETE WITH BONDING AGENT (TYP.)
EXISTING CONCRETE PIER

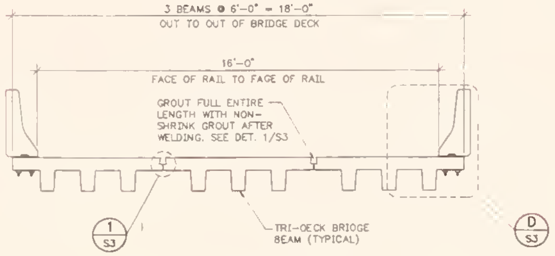
A S3 SECTION
BEAM CONNECTION @ CENTER PIER

1 0 1 2 3
scale feet


L2½x2½x¼
TRI-DECK BEAM
½"ϕ H.A.S.x6" @ 12" O.C.
EXISTING BACKWALL TO BE REMOVED
L1½x1½x¼
PRECAST BACKWALL
L2x2x¼
℄ OF BEARING
6"
6"
3"
2½" TYP.
BENT ℙ ½x8x8x8, ONE EA. SIDE OF CENTER LEG OF BEAM. PROVIDE 2-1"ϕx12" S.S. ANCHOR BOLTS EACH PLATE
½"x5"x8" ELASTOMERIC BEARING PAD (TYPICAL EACH LEG)
EL.=3606.75 TOP OF DECK
PRECAST BACKWALL
¾" CHAMFER (TYP.)
EL.=3605.38 TOP OF CONC.
6"
16"
#4 @ 18" O.C.
#4
EL.=3604.33± TOP OF EXIST. CONCRETE
#4 @ 12" O.C.
10"
24"
2'-6"
EPOXY GROUT INTO EXISTING CONCRETE W/HILTI C100 OR EQUAL. EMBED 6" (TYP.)
8"
#4 @ 18" O.C.
6"
12"
1'-4"
REMOVE THIS PORTION OF EXISTING CONCRETE BACKWALL
EXISTING SPILLWAY WALL TO REMAIN

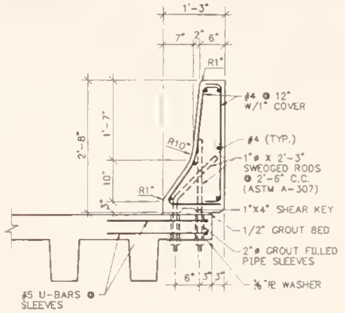
B S3 SECTION
BEAM CONNECTION @ SPILLWAY WALL

1 0 1 2 3
scale feet


3 BEAMS @ 6'-0" = 18'-0"
OUT TO OUT OF BRIDGE DECK
16'-0"
FACE OF RAIL TO FACE OF RAIL
GROUT FULL ENTIRE LENGTH WITH NON-SHRINK GROUT AFTER WELDING. SEE DET. 1/S3
1 S3
TRI-DECK BRIDGE BEAM (TYPICAL)
D S3

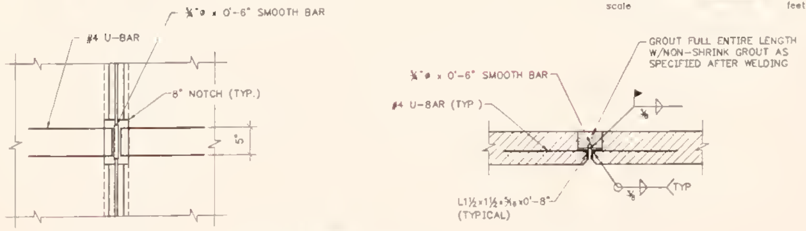
C S3 SECTION
TYPICAL BRIDGE SECTION

1 0 1 2 3 4 5 6 7
scale feet



D S3 SECTION
TYPICAL BRIDGE BARRIER RAIL

1 0 1 2 3
scale feet


#4 U-BAR
⅝"ϕ x 0'-6" SMOOTH BAR
8" NOTCH (TYP.)
5"
⅝"ϕ x 0'-6" SMOOTH BAR
#4 U-BAR (TYP.)
GROUT FULL ENTIRE LENGTH W/NON-SHRINK GROUT AS SPECIFIED AFTER WELDING
¼
TYP
L1½x1½x⁵⁄₁₆x0'-8" (TYPICAL)

PLAN VIEW

SECTION

1 S3 DETAIL
FLANGE CONNECTION

1 0 1 2
scale feet

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· Bozeman & Miles City, Montana

JAMES P. SCHILKE
7/26/94

● Project No BM087.144 ● S3.DWG ● Date JULY 1994 ● Designed JPS ● Drawn DWM ● Checked ● Approved

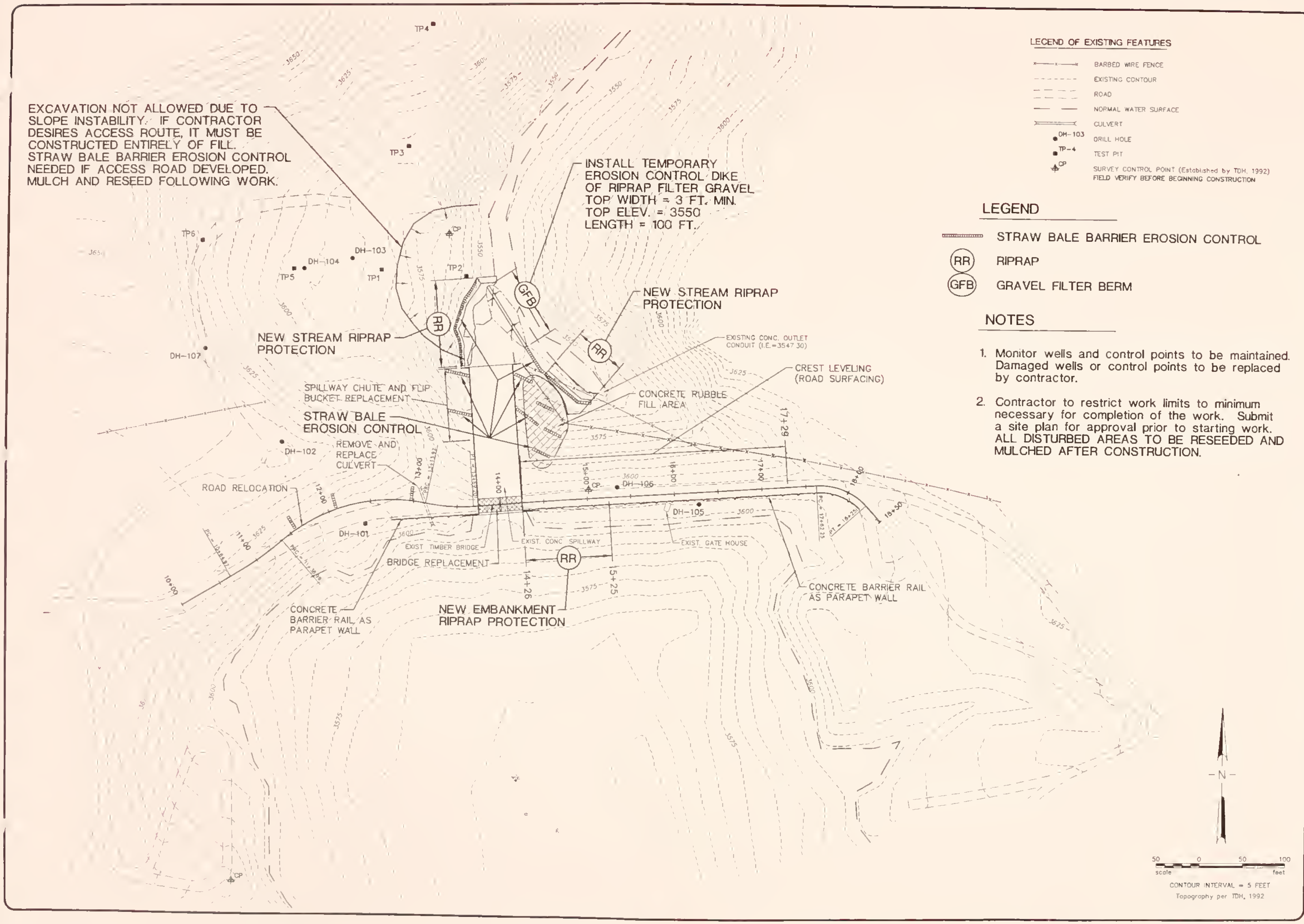
BEARPAW LAKE DAM
HILL COUNTY, MONTANA

SPILLWAY BRIDGE

WARNING
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

No.	Revision	By	Date

Sheet No.
S3
of 3


EXCAVATION NOT ALLOWED DUE TO SLOPE INSTABILITY. IF CONTRACTOR DESIRES ACCESS ROUTE, IT MUST BE CONSTRUCTED ENTIRELY OF FILL. STRAW BALE BARRIER EROSION CONTROL NEEDED IF ACCESS ROAD DEVELOPED. MULCH AND RESEED FOLLOWING WORK.
INSTALL TEMPORARY EROSION CONTROL DIKE OF RIPRAP FILTER GRAVEL TOP WIDTH = 3 FT. MIN. TOP ELEV. = 3550 LENGTH = 100 FT.
TP4
TP3
TP6
TP5
DH-104
DH-103
TP1
TP2
DH-107
DH-102
DH-101
DH-106
DH-105
CP
GFB
RR
NEW STREAM RIPRAP PROTECTION
NEW STREAM RIPRAP PROTECTION
EXISTING CONC. OUTLET CONDUIT (I.E.=3547.30)
CREST LEVELING (ROAD SURFACING)
CONCRETE RUBBLE FILL AREA
SPILLWAY CHUTE AND FLIP BUCKET REPLACEMENT
STRAW BALE EROSION CONTROL
REMOVE AND REPLACE CULVERT
ROAD RELOCATION
EXIST. TIMBER BRIDGE
BRIDGE REPLACEMENT
EXIST. CONC. SPILLWAY
EXIST. GATE HOUSE
CONCRETE BARRIER RAIL AS PARAPET WALL
CONCRETE BARRIER RAIL AS PARAPET WALL
NEW EMBANKMENT RIPRAP PROTECTION
10+00
11+00
12+00
13+00
14+00
14+26
15+00
15+25
16+00
17+00
17+29
18+00
18+50
3550
3575
3600
3625
3650
N
50
0
50
100
scale
feet

CONTOUR INTERVAL = 5 FEET
Topography per TDH, 1992

LEGEND OF EXISTING FEATURES

─x─x─	BARBED WIRE FENCE
- - - -	EXISTING CONTOUR
— — —	ROAD
—— ——	NORMAL WATER SURFACE
═══	CULVERT
● DH-103	DRILL HOLE
■ TP-4	TEST PIT
⌖ CP	SURVEY CONTROL POINT (Established by TDH, 1992) FIELD VERIFY BEFORE BEGINNING CONSTRUCTION

LEGEND

▨	STRAW BALE BARRIER EROSION CONTROL
RR	RIPRAP
GFB	GRAVEL FILTER BERM

NOTES

1. Monitor wells and control points to be maintained. Damaged wells or control points to be replaced by contractor.
2. Contractor to restrict work limits to minimum necessary for completion of the work. Submit a site plan for approval prior to starting work. ALL DISTURBED AREAS TO BE RESEEDED AND MULCHED AFTER CONSTRUCTION.

• Project No 8M087144 • ECI DWG • Date JULY 1994 • Designed • Drawn • Checked • Approved

No	Revision	By	Date
1	REBID		12/14/94

WARNING
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

BEARPAW LAKE DAM
HILL COUNTY, MONTANA

EROSION CONTROL PLAN

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Sheet No.
EC1
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